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By Oliver S Lyon

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A WELL GROWN YOUNG COCOANUT

A READER

OF

ELEMENTARY TROPICAL AGRICULTURE

ADAPTED TO FARMING IN THE PHILIPPINE ISLANDS

BY

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OF THE
PHILIPPINE BUREAU OF AGRICULTURE

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PREFACE.

The objective points of this little work are: primarily, to furnish an elementary text book on agriculture, so modified as to meet the requirements of farming in the Philippines; secondly, to so collate and popularize the information given that it will prove available as a school reader; and, lastly, to amplify some closely correlated matters of domestic and sociological economy that it seems desirable to impress, for general educational purposes, upon the Filipino youth of both sexes.

The subject is one that, popularly or in no other way, can be made to appeal to the very young; nor is it desirable, from an educational standpoint, that the study should enter into the curriculum of children under twelve to fourteen years. On this account, the subject is treated in the style that conforms to the requirements of a third or fourth grade school reader.

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A READER
OF
ELEMENTARY TROPICAL AGRICULTURE

PART I

CHAPTER ONE

THE FARM

1. Definition. The farm is the land that gives the food we eat, the drinks that we drink, the material for the hats, shoes, and clothing that we wear, and ofttimes the house that shelters us.

2. Branches of farming. Fish, the once wild beasts, birds, and insects of mountain or valley are now grown upon the farm for food, feathers, silk, and wax. The business of growing each of these different things is called a branch of farm industry.

The farm has been called the nation's backbone. To it the nations, in their peril, have always turned for the flower of their armies, for the wisest of their counselors, and for the stores of food that are as much needed, in times of war, as arms and ammunition.

3. The farm as a school. The farm is a school of practical education. It teaches more than farming. From its teachings we learn self-reliance, independence, and resourcefulness more than from any other art or craft. It alone has letters-patent to the purest of air and water, the freshest and most wholesome of foods, and to that health of body and peace of mind that town life does not always bring. It is, unfortunately, true that the farm is too often the birthplace of airs the most vile, of waters the most impure, foods the most unfit, and of diseases the most pestilent. These conditions, most times, may be traced to the ignorance or slothfulness of the farmer and are not evils inherent to the farm.

4. The farm as a home. To the farmer, the farm is home in every meaning of the word. Its every field, tree, stream, or stone recalls some event of his life or that of his family and, in time, he comes to regard it with an affection that a town house—a mere pile of brick and mortar—seldom inspires. Out of this love of home flows the love of country that we call patriotism, and patriotism is the corner-stone on which all government rests.

5. Farming. Farming is an operation carried on by man, helped by that which we vaguely call Nature. The word has many definitions; but "the growing of something useful to man where nothing useful grew" is one which will serve our purpose well enough.

Farming is making, creating, and building up. It is the use of brain and muscle to compel the land to give of its riches to the one who farms.

Farming may be done by the untrained in mind and by those unskilled except in the use of their muscles. Such farming becomes drudgery. It may harden the hands, but will soften the brain, and seldom brings more reward than enough to meet the actual needs of the passing hour. When muscular effort is combined with intelligent purpose or knowledge, then farming becomes an honorable and profitable calling.

6. Intelligence in farming. With a simple illustration let us show the difference between the two. I know, and the most ignorant may know, that we must dig the land to plant a yam. Another may dig his land for twelve inches and I mine for only six; yet our crops turn out alike and I have saved a hundredfold in mere drudgery. Or, we may each dig a hole for a young cacao plant, mine to be two feet deep and his as many inches. At first, he will seem the gainer; but, if in after years my tree gives twice as much fruit as his, my work should not be called drudgery, but intelligent, well directed labor.

Farming is a career whose paths are so many and widespreading, and the time and knowledge to explore all of them so far beyond the grasp of most minds, that the calling is fast becoming specialized. That is to say, the modern farmer no longer tries to grow a little of everything and badly, but devotes himself to doing one thing and doing it well.

7. General farming. Where "general farming," as the growing of many crops is called, is still followed, it is done as part of an intelligent system that has two ends in sight: one, the raising of good crops; the other, keeping the land at all times in good, productive condition. One of the means by which this last is effected is called "crop rotation," and we will have more to say about it by and by.

8. Special farming. Special farming takes as many names as the industry has branches. Thus, we have sugar planters and rice or grain growers. Those who raise vegetables for market we call truck farmers. The breeding of cattle, horses, sheep, hogs, and goats is known as stock farming, and as dairy farming when horned cattle are reared for the purpose of milk, butter, or cheese. Those who grow trees that produce something besides timber, who raise spices, tea, coffee, cacao, cocoanuts, mangos, and oranges, are called horticulturists; and we still more closely separate them into nut growers or fruit growers, as the case may be.

Besides these, we have feather farmers who raise ostriches for their fine plumage; poultry keepers, who grow nothing but domestic fowls; perfumery farmers, who plant ilang-ilang, champaka, or other things from whose flowers, leaves, or roots perfumes are extracted; sericulturists, who raise the caterpillars from whose cocoons silk is spun; and apiarians, who rear bees for their wax and honey. We also have nurserymen, who grow the young fruit or nut trees for the horticulturist to plant; seed farmers, upon whom the general or special farmer depends for the quality of the seed that he sows. Last of all, we have the flower farmer or florist, whose care is the cheering of our homes with flowers, and with it the consequent refinement and betterment of our lives.

9. Woman's work. Many of these branches of special farming are within the sphere of woman's work, do not call for such hard labor as women now do in the rice fields, and will pay a better money return on the same investment of pluck and industry.

10. The farmer. We come now to consider the man the central figure of the farm. Upon his personality the success or failure of the farm mostly hinges. His example sets the pace, and his ways in time will be the ways of his family and dependents. Therefore, be he rich or poor, he should practice or countenance neither waste nor sloth, or both will quickly become the heritage of those about him.

11. Value of good work. There are two elementary things for the farmer to learn, that may not be acquired from books—two things more important than the succession of the seasons, more helpful than the fall of the rains, or the quickening alchemy of the sun. One is to learn how to work; the other, to respect the dignity, honor, and worth of good work from others. He may not always need to push the plow himself, but he must do so at some time in his career if he would hope to have others operate it to his best advantage. He must be familiar, from practical use, with every detail of a plow's construction, and know the particular work that each part is called upon to perform. Else, when "things won't work," how may he hope to remedy them with the help only of those more ignorant than himself? How may he determine and discriminate a good job of plowing unless he has done and is, therefore, capable of doing good work himself?

12. Value of practical experience. We may have learned all that a colored print or diagram can tell us of human anatomy, but we may not hope to successfully amputate a living leg till we have first dissected many a dead one. So the farmer, who would have others operate the tools of his trade for him, must first have served an apprenticeship in their use. This applies from the simplest tool up to the most complex machinery used upon the farm.

There is a right, a correct use of such primitive tools as spades, forks, shovels, hoes, and rakes; and that use is one that will give the best results with the least breakage of backs and implements.

The farmer must fear no contamination from the soil. That which we call the dirt of the land is the cleanest of all dirt and, although it begrimes for the time, yields sooner than others to soap and water. Hard or calloused hands may spoil penmanship, but will generally help a rice crop. It may be that the farmer can no longer make a pretty flourish under his signature, but he will be able to control an unruly carabao, or to right a crooked fruit tree. These things will help to give him a bank account, and the bank will pay his cheque as readily if his name is signed without as with a flourish.

13. Brain work on the farm. If he acquires a modern farm training, that training will help him to cut out much of the drudgery that now results in calloused hands and backs bent double with toil. He may now plant a hundred hectares in tobacco or tomatoes without ever stooping once to open a hole or set a plant. Nor need any man in his employ do otherwise than himself. By the use of his brain he may supplement the work of his hands to make lighter the work of the latter. But work, honest work, physical and mental, he cannot evade; and the earlier he takes this lesson to heart the more assured will be his success. He may sit in the window of his town house and from afar direct the work upon the farm; but, when his money is all gone, he will declare that farming is a failure. If he succeeds, it is because he is in person upon the land, either following the plow or directing others.

Notwithstanding this, he will sometimes fail. There are adverse seasons; defects of seeds or soils; there are diseases and insect pests with which to contend and whose ravages may crown his best efforts with poor results. Nevertheless, the farmer who is fully trained in his calling has many advantages over him who has learned only to sow and reap. At these times the education that trains to observe—to see with the mind as well as the eye—serves a good purpose.

14. Scientific training. To the one so trained the adverse season is often within control. If the cause be drought, he will have learned how to preserve and obtain whatever moisture there is in the soil, and be able to put in practice the means to effect it. If it be flood, he will understand how to drain his lands and save his crop, in whole or part, while those adjoining may be lost. If it be plant disease or insect enemy, his study and investigation will have placed many weapons at his command with which to fight the foe.

15. Books. The more he learns from books the more deeply he will take the lessons to heart that what they teach is but a framework whose value depends upon the persevering work with which it must be combined; that sustained, continuing, and intelligent effort is the key-note to a successful issue of the farm, and that agriculture at long range is a delusion and a snare.

16. The farmer's home. The wise farmer will cultivate his home as well as his lands. His house may be small and poor, but should be neither squalid nor dirty. He should learn that he and his kind belong to a higher plane than do pigs or poultry and that it is neither cleanly nor elevating to have them roaming about his house. It should be his aim to make his home the most attractive spot on earth. This is the surest way he can retain his children about him and arouse in them as great an interest as his own. He should dedicate to them land that they can work for their own profit. This will give them practice in the use of tools, will increase their health

A PHILIPPINE FARM HOUSE

and strength, and working sometimes for themselves, will make them self-reliant. He should be careful not to impose too much work of drudgery upon his children; it will breed a distaste and hate for the farm that he should ever strive to avoid. His home, however small and poor, should be made bright and cheerful. If he cannot afford to buy beautiful things or luxuries, he can always afford to have flowers instead of art works, and abundant fruits and vegetables instead of costly wines and foreign delicacies. Too often he thinks that these flowers and fruits bring him in no money, and so he neglects them, and there is nothing in or about his home to give his children pleasure. There is nothing to make them forget the toil of the day and, as soon as they can, they escape to large cities, there to often follow pursuits less honorable and less remunerative than farming.

17. Refining influences. The brightness, cheerfulness, and beauty of his home will refine his children; make them better every way than they would otherwise be, and every farmer or father should only look for the betterment of his children. He is unwise most times if he tries to make doctors, lawyers, or teachers of his sons. But, if he knows his own craft well, he can hope to make better farmers of his sons than himself, and that is a great step towards their betterment. He should make it a purpose of his life to see that his daughters' schooling includes training in domestic economy—that is, the arts of sewing, cooking, hygiene, and the care of children. These are attainments more useful than embroidery, painting, or piano playing, and will equip them to be farmers' wives—better wives than their own mothers were.

There is no poverty so abject, no farmer's lot so hard, that he may not command the blessings of cleanliness and the simple luxuries that we mentioned before. The flowers he cultivates are silent educators in taste and, after a few years, he or his children will pull up in disgust the empty bottles they once thought so pretty as they stuck them in geometric designs about the flower beds.

18. Amusements. If the farmer prospers, let him surround himself and children with every innocent amusement the farm can afford. Let him provide for and encourage his boys and girls alike in all athletic games and sports, such as ball, tennis, billiards, swimming, riding, or dancing, and in such pleasures as will endear the farm to them forever and make it a home in much more than name.

CHAPTER TWO

THE SOIL

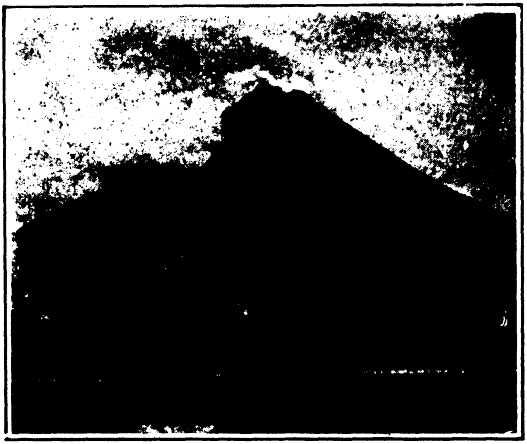
19. Soil relations. The soil—the land itself, its nature and uses—has ever been considered the first matter for the farmer's attention. This may have come from the habit of thinking so, but, more probably, because the soil is the most tangible thing upon the farm. In time we will learn that there are four other things of equal importance and that, without sunlight, air, water, and work, the soil is an inert mass, without further value to the farmer than that given to it in connection with these other things. Soil study is a science brimful of useful knowledge, but the farmer's interests only require that he shall know of it in relation to the things named above, and from this point only will we discuss it.

20. Soil composition. The soil is mostly made up of rock and stone, things that, as we understand them, unless quite deeply buried, are a decided nuisance on the farm. They become the soil that makes the land we use for farming when they have been ground to a more or less fine powder and, as a general thing, the finer the powder the more useful to the farmer. This grinding has been done in many ways, but in our country the hot sun and the heavy rains have done most of it.

21. Causes of formation. We all know that a dead fish will quickly decay in hot, moist weather, and, although the process takes longer, anything devoid of life—even a rock—like the dead fish will decay in time. Some rock is hard and flintlike and its decay may take thousands of years. Others are soft and begin to crumble away in a few years or even months. The influences at work to crumble rocks are inconspicuous and will escape the notice of those not trained to habits of close observation.

But small details will not escape the observant farmer. He will see that a heavy rain splashes tiny grains of sharp sand against a rock or perhaps a stone wall and that, in the span of his own life, the constant drubbing of the sand has eaten into the hard stone.

22. Kinds of soil. Sometimes soil making is done upon a large and rough scale. A jam of fallen trees may clog or dam up a water-course until the weight of penned up waters is great enough to tear away the obstruction. The force is sometimes so great that big boulders are tossed about like corks and in rolling and pitching about against one another are broken into coarse pieces. The soil they make, when in this form, is called gravel. When still coarse, but free from perceptible lumps, it becomes sand. When still finer, and mixed with other things, of which we will speak later, it is known as loam; and, when reduced to powder so fine that it becomes smooth or even greasy to the touch, we call it clay.



MAYON VOLCANO
A soil maker.

23. Volcanoes as soil makers. Soils are sometimes created or added to in large amounts by the eruptions of volcanoes. When this occurs, floods of melted rock, called lava, pour out and sometimes flow like rivers for many miles in different directions. This lava, on cooling, undergoes the processes of decay common to other rocks, and in our country is the source from whence our best soils have been derived.

Sometimes volcanoes belch forth incredible quantities of ashes, the fine dust of which is often carried many hundred miles away, while the ashes have entombed entire nearby cities.

24. Nature as a farmer. Still another source of soil making is from the farmer whom we will call Nature who, as a grower, a producer, appeals to us more humanly than as the same power that builds up the mighty rocks and then grinds them to dust for our use. Nature, in her own good way, farms or grows most of the things we need and many whose uses we do not yet understand. Her creations are so many, and the world is so crowded with them, that she has had to devise many ingenious ways to protect them. Some, like cactus, she fits for thriving on arid, desert sands; others, like mosses and lichens, to grow upon the very rocks; some, like rice, to live in the swamps or in actual water; while others, so overcrowded with plants is the soil of her farm, she has provided shall grow and live as parasites upon the juices of other plants. Besides this, she has protected some plants with stinging hairs, armed others with cruel thorns, and others with deadly, poisonous juices. Others, that are eagerly sought by man or animals, she has provided with enduring roots and stems that continue to grow year after year, and to give of their leaves, flowers or fruits, notwithstanding being despoiled time and again; others, with seed in such profusion that some of it is certain to be left on her farm, regardless how much sought for by other living things.

25. No waste in nature. In making provision for her vast family, Nature farms wisely and well. She is constantly giving to the soil the things most needed by those who live in or by it. Nothing goes to waste. She carefully turns back into the soil every dead animal, leaf, twig, branch or mighty tree that has fallen by the wayside. These things quickly become soil of the best kind, and Nature seems to be constantly adding to the supply. Such, however, is not the case, and she only restores in one form what she has taken away in another.

26. Additions from inundation. If one of her rivers overflows its banks in flood time, when the waters abate, a film of the very finest soil is deposited over the valley. Sometimes this deposit is several inches thick and, like the dead leaves and twigs, is a seeming addition to the soil, but in reality it is only soil brought from one place and lodged in another. When the waters dry up, the material left behind, and which we call silt, becomes a precious and useful addition to the soil of the farm.

Nature's method of farming is, therefore, on a scale of broad liberality, and teaches us the general lesson to take nothing from the land that we do not sooner or later restore. By study and experience the progressive farmer has modified these teachings to his own advantage. He has learned that he may withdraw from the land the crops that he wants and restore other things of less money value. He thereby maintains the same balance that Nature does. His land always remains in a productive condition, and the difference in money value between what he adds and that which he takes away represents his profits.

27. The soil only raw material. The soil of the farm may be compared to the logs brought into a sawmill, which have no actual usefulness until they have been cut, dressed, or shaped into other forms. The direct and visible use of the soil extends no further than to furnish a support—a holdfast whereby the plants may grow. It contains none of the foods which plants may feed of and grow upon, but only the raw material of which their food is finally made, and is no more a plant food than a piece of bullock's hide, a few nails, eyelets, and some waxed thread are a pair of shoes.

28. Nature's workshop. From this we learn that the soil is a workshop, one of "Nature's laboratories" we call them, where incessant work is being carried on, and a knowledge of how this work is performed is as useful to the farmer as a knowledge of how those other things should be combined is useful to the shoemaker. From this we may learn that the different substances in the soil may be so treated that the plant has no trouble in collecting and turning to good account the raw material of which its food is made up, or encounter such difficulties that it fails to get them in the desired quantities or condition. In the former case, the plant will make a splendid, vigorous growth, that is but another way of saying it will make a fine crop; in the other, a feeble or stunted development, that is equivalent to poor crop, or failure. The difference in value between the two represents the importance to the farmer of this knowledge and its application to his farming operation.

We have said that Nature farms with a lavish hand; yet she supplements her bounty with work. This work is largely carried on underground, removed from our vision but, nevertheless, goes on unceasingly. The farmer who knows his craft follows her example, but in a more expeditious way. He finds that work—labor—is one of the most valuable returns for that which he takes away as crop, and the form in which he applies this labor is in breaking up the soil into looser, finer particles.

29. Effects of rain and sun. Under our hot sun and heavy, beating rains the soil becomes a dense, compact mass into which both air and water penetrate with great difficulty. If you can find an unburned brick, you can make a simple test to prove this to your own satisfaction.

Fill a small cardboard or wooden box, about the size of the brick, with any loose, dry soil, and expose both brick and box for a few minutes to a hard shower. Then, break open the brick and you will find it moistened hardly to a depth of one cm.; but the soil in the box will be damp quite to the bottom.

Anything waterproof is not necessarily air tight, but, generally, they are properties that go closely hand in hand; and the brick, or a bricklike soil, admits air with almost as much difficulty as water.

30. Plants like animals. The important part that these two things—air and water—play in connection with the soil is easily explained. Plants are living creatures and, like all other living things, require food to eat and air to breathe. Like very many animals, they are unprovided, however, with any means of taking their food except as drink.

We are apt to think of living things as obtaining their food by biting, chewing or swallowing, but if you will examine the fruit of an Ati in dry weather, you will frequently notice a quantity of small, flat, white scale insects which live upon the sweet, watery juices of the fruit. These little animals have no other nourishment than this drink that they procure by sucking, and, in almost precisely the same manner, the plant procures most of its food supply by sucking it through the roots.

The soil is full of small particles of materials that are particularly relished by plants as food, but it matters not how abundant or how fine these are, the plant cannot eat them until melted or, as we say, dissolved in water.

31. Conversion of soil to plant foods. Some of these choice food morsels will not dissolve in water alone; they must also be worked upon by the air. Air, as you probably know, is a mixture of gases, and the property of one of these gases, called oxygen, is to burn things up. This burning is rarely accompanied with fire or smoke, but is a slow burning that we call decay and is a process to which all dead things exposed to its influence are subject.

For this reason, when we desire to preserve dead fruits, vegetables or meats, we seal them tightly in glass or tin vessels so as to exclude the air and prevent decay.

32. Source of nitrogen. Furthermore, there is a particular material or element in all dead animal or vegetable matter that is essential to the well being of all the crops that the farmer grows. This element, called nitrogen, is locked up in the dead matter in the soil, and cannot escape, or be used, till it is burned out and set free by the air. When this element is set free by this burning out, it seeks the companionship of some of those particles that water does not affect, forms with it a partnership so intimate as to change the nature of each, and produce a compound that melts as freely as salt or sugar and, in that state, is greedily drunk up by the plant. It follows, then, that working or stirring the soil, or any operation that freely admits the entrance of both air and water, is helpful to the plant and, consequently, beneficial to the one who grows it.

33. Importance of air and water. To demonstrate the equal if not greater importance of both air and water to plant life, than even the soil itself, a simple experiment within the reach of every one is here suggested.

Take a few handfuls of sharp, white, builders' sand, and boil it for twenty minutes in water that has been made sour with sharp vinegar or any weak acid. After this, wash it clean in two or three washings of pure rain water. We select sand because, if pure, it contains only in the minutest quantities those things that plants turn into food; and we use boiling, acidulated water to dissolve out and wash away the few particles of plant-food material that may stick to the grains of sand. Now, to complete the experiment, and make the sand completely sterile, place it in a clean, earthen rice pot and roast for a while over a hot fire. When thoroughly cooled off, plant a few grains of rice or corn, and keep well watered with nothing but rain water. Rain water is selected, because free of nearly all traces of plant food material, while that of rivers or streams sometimes carries it in considerable supply.

In a few days the seeds will sprout and, though they will not grow up to mature flowers and seeds, you will be surprised to see the considerable growth they will make on a diet of air and water alone. Had the seeds been planted in the fine dried sand, and unwatered, they never would have sprouted; nor, though watered, had you placed the pot beneath the receiver of an air pump, from which the air had been exhausted, would they ever have sprouted any more than in the stone dry sand.

The processes by which these experiments are wrought out are underground, concealed from our actual powers of sight; but, if you are observant, you may see in your daily walks and experiences examples that make clear the all-sufficiency of air and water to bring many plants to the highest degree of perfection.

34. Orchids independent of soil. Of these a striking illustration is found in our many beautiful orchids that you find in the deep, sheltered forest ravines, or may see clinging to sticks or bits of wood in so many of our town gardens. They are commonly but erroneously called parasites; but a parasite, we have found out, lives only on the juices of the host, as its victim is called, and promptly dies if death befalls its host. But the orchid flourishes long after every trace of life has vanished from the plant to which it clings merely for support. Their behaviour also furnishes conclusive evidence that they are in no way parasitic, but depend on the air and water only for their sustenance. During the dry season they are torpid and inactive; but, after the first few showers of rainfall, they begin to build up new leaves and bulbs, to thrust out their fleshy, wormlike roots into the atmosphere and, finally, at the close of the rainy season, to burst out into magnificent flower.

35. Stagnant water undesirable. While these various illustrations point to the necessity to most plants of an abundant supply of both air and water, neither should be foul or stagnant. Most plants grow in what we vaguely call the dirt, yet many are more sensitive in the matter of cleanliness than some farmers and, notwithstanding their love of water, with few exceptions (of which rice, a truly aquatic plant, is one), stagnant air or water quickly proves fatal to them.

The ferns that line the borders of ravines or water-courses afford a pretty illustration of this. Here, where the water oozes from the banks, you may see it trickling down over the fern roots, keeping them constantly drenched with water that is always in motion. In the quiet pools below, in which this water collects, one never finds a fern, and if you were to transplant one to the margin of such a pool, it would quickly sicken and die.

To farm crops, this movement of water is quite as necessary as to the fern and, although its motion is not visible, it is constantly going on. Stirring the soil so loosens it that the water of rainfall easily percolates through and in a downward current. When the sun shines the current is reversed, for the sun acts precisely as the fire under a pot of water which drives off the water as vapor or steam, and, unless replenished, the pot goes dry.

36. Water movement in the soil. As the sun dries off the surface of the soil, it draws up, to take the place of that evaporated, a constant supply from the depths that previous soil stirrings have enabled the rains to penetrate. Thus, an upward current is established which, in its passage among the plant roots, enables them to find and feed upon the stores of plant food material that it contains, and only the surplus water that the plant cannot drink up comes to the surface and escapes as vapor.

This upward movement of water in the soil sometimes progresses too fast. This occurs when the days of bright sunshine far outnumber the days of cloud or rain. When this occurs the plants begin to suffer from what we call drought. In this case we resort to stirring the soil for another purpose and in another fashion. These stirrings are done with implements having numerous small teeth arranged so as to cut or tear the surface soil into very fine particles.

37. Cultivation as a mulch. This operation we call cultivation and its effect is to close or choke up some of the largest air holes so as to prevent the escape of the water or its vapor as rapidly as would happen if the surface were left roughly broken. If you would determine the truth of this from your own observation, place a wide piece of board on the ground a day or two after a rain. Near it arrange as closely as you can enough strips of split bamboo to cover as much soil space as does the board. After a few days of bright sunshine, remove both, and you will find the soil under the board still quite damp, while that under the bamboo strips will be nearly dry. The difference between the two is the value between a close and a loose fitting cover. The finely pulverized surface left by good cultivation representing the close cover of the board; the rough, lumpy surface left by the plow answers to the ill-fitting strips of cane.

Thus it is seen that cultivation of the soil serves two very important purposes in its effect upon plant life: one, that it places the soil in the best receptive condition for the waters of rainfall; the other, that it retards its too rapid escape through evaporation.

38. Explanation of mulching. Both the board and the finely tilled soil are illustrations of what is known as "mulch," and farmers take advantage of it in dry weather, to cover the soil about trees, or places they cannot reach with a cultivator, with weeds, grass, or other waste material. Aside from these purposes named, cultivation serves the very important end of destroying weeds, a subject calling for especial consideration and which will be taken up in another place.

39. Important food elements. With one exception, the soil contains all of the raw material that plants require to perfect their growth. There are about ten of these substances that enter into their dietary. Most of these they use in very minute quantities, only four—to wit: nitrogen, potash, phosphorus, and lime—being wanted in large supply.

40. The wearing out of soil. As soils abound or are wanting in one or more of these elements, we speak of them as rich or poor lands. Particular crops call for one or more of these materials in large quantities and, according as they are plentiful or scarce, we speak of the land being well adapted or ill fitted to grow the crop in question.

Crops planted on lands well adapted for them are generally the most profitable; but, if their growth is continued for many years, and no return is made of the plant food that they withdraw, such lands become impoverished and worn out. The prudent farmer, therefore, changes his crop plantings frequently; or, if his land is in such permanent plantings as cocoanuts, coffee, or cacao, he effects the same purpose by adding to the soil an equivalent for that taken away by the crop. The first of these operations is called rotation, and the second manuring. Each will be considered in its proper place.

CHAPTER THREE

PLANT RELATIONS TO SOIL AND AIR

41. Material taken from the air. It was said elsewhere that the soil furnished all the ingredients of plant food except one. That one is carbon which, in one of its forms (a poisonous gas), is found in the air about us. All animals take it into their lungs, but immediately expel it. Plants likewise absorb it during daylight, but, instead of expelling it, retain it and convert it into their food. It is the only food material that plants do not take up through their roots. It is taken in through a multitude of tiny openings that cover the under surface mostly of all green leaves. These openings, called stomata, are too small to see without a microscope. You may prove that they are there, and show their purpose, by covering the upper surface of one leaf and the lower surface of another with a coat of shellac or of any fine white varnish. In a few days, if there is plenty of sunlight, the leaf varnished on its lower surface will turn sickly and yellow, but no harm will befall that which has been treated on its upper face where these stomata are relatively few in number.

42. The change into food. This carbon gas, when taken into the plant leaf, undergoes remarkable and complex changes in which the green coloring matter of the leaf and the watery juices that have been sucked up by the root all play important parts. It is here, in the leaf, and under the influence of daylight, that these various materials are converted into actual food. This food is starch, sugar, and that material seen in a pure state in the white of an egg, and which we call albumen. Just such foods, then, as animals require make up the dietary of plants. More provident, however, than most animals, and even some human beings, the plant not only supplies its immediate wants, but, by dint of tireless work, makes provision against famine times, and lays up reserve stores of food for its offspring or other emergencies.

43. Storing up of food. You may see a pretty illustration of this in a piece of sugar-cane, or in the tuber of a native tugui, or an American potato. The sugar-cane seldom perfects seeds, but, when the ripe cane is laid in moist soil, it will emit roots and make a new plant. At first the roots are feeble and can not supply all the material that the stout, rank growing leaves require, and the young plant falls back upon the sugar supply that was stored up in the old cane. It is within your power to determine this by a simple experiment.

SUGAR-CANE FROM HAWAII GROWING IN THE PHILIPPINES

Plant three pieces of ripe cane and, in a few days and before any sprouts have pushed out, take out one of the pieces, wash, cleanse, and taste, and it will be found nearly as sweet as when planted. Take up the second as soon as the sprouts appear, and the third as soon as they are a few centimeters high. On tasting them you will find that much of the sweetness has gone from the second and every trace has vanished from the third.

44. Consumption of reserve food. This indicates that the young plants have used up this sugar—fed upon it—until the new roots could support them.

Likewise, the tugui or the potato, if left in a warm, damp place, will push out what we call "eyes." These eyes or sprouts will sometimes grow to considerable length and, in fact, continue to live without any roots until all the reserve starch that the old plant had stored up in the tuber is exhausted. If you cook such a tuber, you will find it very watery and unpalatable, a proof that all the good—the starch—has been consumed.

How may it benefit the farmer to know and understand these various processes by which plants derive their nourishment? The sugar-cane will again serve to illustrate.

He starts his field and does all within his power to encourage growth. He plows, he cultivates, irrigates, and manures his land. He strives to make all the strong leaf growth he can, he knows that the leaf is the laboratory in which the sugar he is after must be made. He knows that, like any other machine, it must be well fed to do its best work, and that without much leaf there can not be much cane or sugar.

Now, at a certain stage, he applies his knowledge of how plants feed to "lay by" his cane, to discourage further leaf growth in order that the food, the sugar, that the leaf would otherwise consume, may be stored up in the cane. If, however, he proceeds without this knowledge, he will continue to cultivate, to irrigate, and to manure. He will, in consequence, secure a great harvest of cane, but much of the sugar that he is seeking has disappeared.

45. Relation to soil. The plant derives its soil supplies of food material from the root, so the careful farmer aims to have the roots of the plant in as healthy and thrifty a condition as the leaves.

The old roots of plants serve the purpose only of anchors, to hold the plant securely in place. All the feeding is done through the finest roots by the aid of the tiny hairs that clothe them. These hairs are of so much importance that we will have more to tell about them in another place; at this time no more than to say that through them the fluids that nourish the plant are absorbed and find their way to the tops of the loftiest trees. These fluids, when once within the plant, are called by the name sap.

46. Movement of the sap. The process by which sap overcomes the laws of gravitation and climbs to great heights is not clearly understood; but, of a number of things that contribute, "root pressure" is one of the strongest. Root pressure may be likened to the pump action of the heart that suffices to drive the blood into every part of the body.

Other influences are osmosis and capillarity, terms whose significance you will understand when you come to the study of elementary physics.

After the sap reaches the leaves, it undergoes changes that convert it into food and, when thus prepared, flows downward, being consumed as it travels, according to the requirements of the different growing parts of the

Plant. A knowledge of the fact that the sap returns to the root is of more practical importance to the farmer than the processes by which it is accomplished. This knowledge he often turns to account in pruning his fruit trees or in hacking and unnecessarily mutilating the trunk of a mango tree, as so many of our farmers unwisely do.

The descending sap, when it is arrested by a cut limb or branch, is checked in its flow. Sometimes more or less sap escapes and drips out from the wound. Most times the air quickly heals over the wound, and the sap that has quietly traveled along its accustomed channels is suddenly checked. In consequence, the heavier, richer particles become lodged wherever there is an eddy or irregularity in its path, to catch them. These uneven points in its path are usually the axils of leaves, that is, the point where a tiny, undeveloped bud lies. When, from such causes, rich food becomes packed at these points, it results in a swelling or engorgement which finally causes the bud to swell and burst out into growth. As the richest and most abundant food is called for by the flower (which, unless of green color, can not manufacture its own food supply), this bud is apt to develop into a flower and, subsequently, into the fruit the pruner sought.

Hacking the trunk of a mango has the same result. It checks the return flow of sap and drives it into these bud seats as they are called. Precisely the same benefits would occur if a ditch were opened at intervals about the trees and a few strong roots severed. The scarring of the tree not only makes unsightly wounds, but rain water often lodges in them, and decay, disease, and death often follow

The relation between the leaf and the root is now made clear. They are dependent upon each other, and it lies in the farmer's power to command the very plant food in the air that he may neither see, smell, touch, nor taste, by keeping the roots of his plants in such condition that they in turn will contribute their share to the production of the leaves that do the rest of the work.

The method by which this is best effected is by what we call, "SOIL PREPARATION."

CHAPTER FOUR

SOIL PREPARATION

This subject will be considered under three heads:

1.—Clearing the land of undesirable trees, shrubs, or other plants.

2.—Operations that put the land in best condition for general farm purposes.

3.—Operations that best prepare it for growing special crops.

CLEARING THE LAND

The extent to which clearing is performed will depend somewhat on the "lay of the land" and somewhat on the crops to be grown. If the land is sloping, or steep, or receives the overflow rainfall of other territory, it is, in general, bad policy to remove all of the natural tree or shrub growth.

47. Protection from washing. The roots and stems of plants are an effective barrier to the rush of storm waters and often prevent serious guttering and washing away of the soil. One may prove this by throwing a handful of sticks into a narrow ditch of water in such a way that the sticks catch in the bank and are not washed away in the current. The stream is instantly arrested, backs up, and its flow becomes sluggish above the obstruction, and incapable of much damage.

The closer, finer network of plant roots perform this in a more effective manner and, in consequence, we rarely find the serious soil washings in a wooded country that we find in the open.

Soil washings are hurtful, inasmuch as they add to the difficulty of working the land, and carry away into rivers and streams much precious plant food material.

48. To show injury from washing. Determine this for yourself by stretching clear of the ground a piece of old gunny sack, securely made fast at the corners to four stout pegs. On this place a measured ganta of any good garden soil. Pour a bucketful of water over this daily for a week, stirring up the mud every time water is applied When the residue upon the sack is dry enough to handle, turn into a small box, and gather a like quantity of soil in another box, from the same spot where the washed soil was taken. In each box now plant a couple of seeds of patani or calabaza, and observe how much stronger and more vigorous the growth will be of the seeds planted in the unwashed soil.

49. When and what to remove. On steep hillsides or the banks of ravines the native growth should only be removed by degrees, and useful plants gradually substituted that in time will perform the functions of the wild ones. Such places are apt to be sheltered from strong winds and to be composed of rich, well drained soils, peculiarly suited to the growth of cacao, coffee, vanilla, pepper, or small fruit trees. Some of these are benefited by some shading from the sun, and enough of the wild growth should be left undisturbed to accomplish this purpose and to protect the soil from washing.

50. Terracing. Steep sheltered hillsides are often further protected from washing by terracing. Terracing is simply breaking into the hillside and distributing the soil upon a level plane. On digging in such localities stone or small boulders are generally disclosed, and these stones are used in building up a retaining wall against the lower face of the terrace.

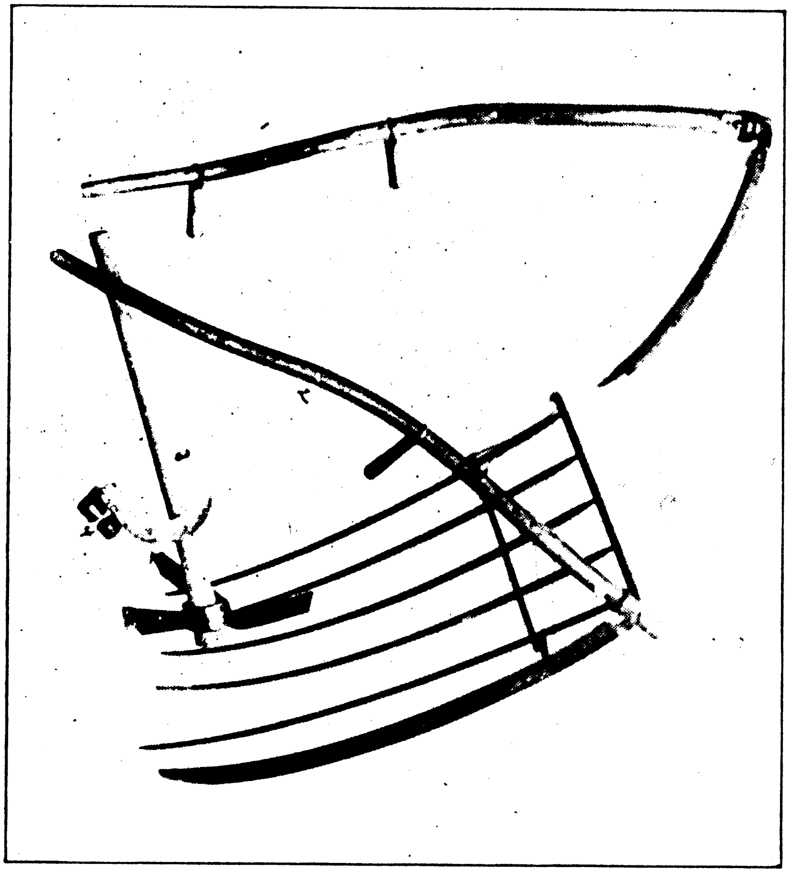
IGORROTE TERRACES

This practice, largely followed by Igorrotes and other mountain people, calls for a serious expenditure of labor, but furnishes ample and enduring protection from the destructive influence of flood waters.

51. Complete clearing. The extent of clearing upon the level lands will depend upon what crops are to be grown. Abacá, cacao, vanilla, pineapple, and, under some conditions, coffee and tobacco, thrive best with partial shelter from the sun's rays. On the other hand, corn, rice, forage grasses, peanuts, yams, sugar-cane, indigo, cotton, cocoanuts, and oranges, all flourish best in unbroken sunlight.

For the former cultivations we, therefore, leave some of the most desirable shade trees and, for the latter, clear everything in sight.

52. Use of clearing tools. Small shrubs and bushes are first cut with a brush hook and the roots then taken out with a mattock. Both of these implements are shown in the picture. The brush hook cuts with an upward, drawing blow. It may be used as rapidly as a bolo and, as the workman can stand quite erect while using it, is not so tiring as a bolo. The mattock is a composite tool. It has a heavy hoe blade, as well as an axelike blade. Sometimes a pick point is substituted for the axe blade and, in stony lands, this combination is the most useful. Large shrubs or small trees are first chopped and the stumps are quickly and easily withdrawn by a stump puller.



HANDY SMALL TOOLS
1. Scythe and snathe.—2. Rice cradle.—
3. Mattock.—4. Brush hook.

53. Destroying old stumps. It is often necessary to fell large trees, but it rarely repays the cost of digging out the stumps. Some varieties will decay in a few years, and others will sprout anew from the base. These latter are best disposed of by boring with an auger a deep hole into the stump and half filling it with saltpeter. In a few months the hole is to be filled up with kerosene and set afire. The saltpeter will saturate the wood and make it inflammable, and the fire will slowly, but surely, eat its way down into the roots. Those roots not wholly consumed are then easily dug out.

Good timber may be disposed of for building or other uses, but all limbs and small brush should be burned on the spot.

This trash is made up of the elements of plant food once drawn from the soil and the air, and burning it simply restores to the soil in another form all of the material originally taken from it in the upbuilding of the tree.

When dry, this trash should be piled in small heaps and burned. Big bonfires are to be avoided. If very large, they will roast the soil for a depth of two or three inches, and burn out much of the humus.

54. Good soil condition. Humus is the fibrous and undecayed remains of plants or animals in the soil. It is a valuable contributor to plant food material and has the additional useful property of improving the physical condition of the soil. We say that the soil is in good physical condition when it crumbles and pulverizes readily under the influence of the tools of farm labor.

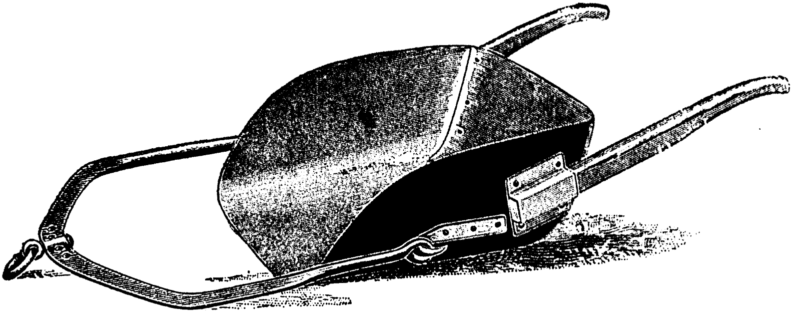
GRADING

55. Uses and definition. Grading is a step in soil preparation whose utility depends much upon the purpose for which the land is to be used. Where lowland rice, or any crop calling for irrigation is to be grown, grading becomes a necessity.

Grading means reducing to a flat and uniform, but not necessarily a level surface. It is effected by cutting down the higher places and filling the depressions with the soil cut down.

56. How to grade. Except on lands that are naturally nearly level, grading to a level is seldom undertaken, as the cost of moving large quantities of soil is very great. So, instead of leveling lands that we desire to flood, we throw up embankments called dikes upon the lowest sides, against which the water backs up until the higher parts of the land are submerged.

57. Implements for grading. When we come to consider irrigation, we will learn that land may be irrigated by ditches and without recourse to flooding. Grading, however, is a necessity in either case, and involves for its most economical performance the use of a plow and a scraper; the plow, to break down the high inequalities; the scraper, to carry off and dump the soil in the low places. There are machines which will both cut down ridges and carry away the soil, but they require heavy animal power for their successful operation, and the common dumping scraper, drawn by two bullocks will do good and effective service. The value of this labor-saving implement increases with the distance the soil is to be moved. In moving it ten meters it will only do the work of two or three men working with shovels; but, if the haul is a hundred, it will probably perform the work of a dozen.



SCRAPER

DRAINAGE

58. Definition. This is the next step in original soil preparation. Drainage is any operation that assists the escape of stagnant water from the land, that quickly carries off the overflow of storm water and that permits of a free circulation of air in the soil.

59. Utility. Drainage is uncalled for upon sandy or on light, porous soil. On all others its use is indicated and, although the practice is unfortunately infrequent, there is no single step in tropical farming of such marked utility to the farmer. Its intelligent application and practice is almost a crop assurance in both times of flood and times of drought. It is a permanent farm improvevement that adds to the productiveness of the land and to its future selling value. It calls for outlay of labor and money; but the resulting benefits are so manifold that the farmer, who will drain one or two hectares of his land, will never stop until little by little he has drained his whole farm. In our dense, heavily compacted clay lands its utility would be so great that much consideration is given to this topic.

60. Drainage by ditches. Drainage may be performed by cutting open ditches or trenches through the land towards some lower point where the water may escape into a natural runway. These ditches should have a slight, uniform fall, or drop towards the lower point. Five or six cm. to each ten meters is generally sufficient for this purpose. The ditches can be opened with a common plow, deepened with a subsoiler, and cleaned out with a shovel. Open ditches are not recommended, except as an expedient when proper drainage can not be given, and as offering something better than no drainage. They must be cut with sloping sides, to prevent filling up with rubbish. They take up much land; they hinder all operations of cross cultivation; they harbor weeds, breed mosquitoes and, at much expense, require constant cleaning out. So, while the initial expense is the least, they in time come to cost more than a proper system.

61. Drainage by tiles. Drainage is also effected by means of tile pipe which, when well and carefully laid, is by far the best system ever introduced. Tile drains are short lengths of clay pipe, generally of about 10 cm. diameter, expanded at one end into a shoulder or collar, into which the smooth end of the preceding end fits loosely enough to admit the free entry of water, but to the exclusion of the soil. The pipe is then laid in the bottom of a trench, at a depth sufficiently great to protect it from contact with the implements of soil working. The trench is then refilled with soil, and the operation is complete. Far cheaper, more accessible and of nearly equal utility would be the common roof tiling in general use in this archipelago. These tiles should be procured in two widths, and the narrower laid top side down, that is, with the convex face on the bottom of the trench. The wider tiles are to be laid as a cap over these, with the top or convex face up, and the trench filled up as in the case of the tile pipe. Such a drain will freely admit water and exclude soil as well as piping.

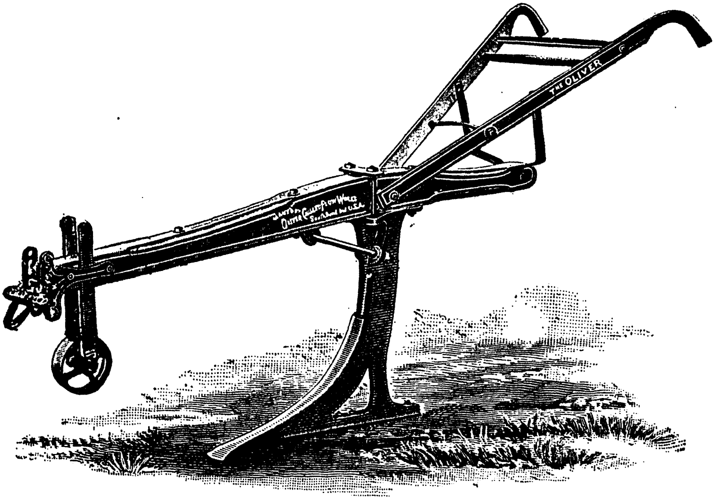
62. Drainage by bamboo tubes. Still a third and last method of experimental value is tendered as an expedient within the reach of every farmer who would avail himself of the many benefits derived from drainage. It is the substitution of bamboo canes for tiling. These are readily cleared of their partitions by the introduction of a slender rod mounted with a sharp gouge chisel. The cutting should be clean, to allow of an unobstructed flow of water, and the taper end of one cane should be well fitted into the butt end of the preceding cane. As these joints will swell and become water tight, it will become necessary to cut small holes at frequent intervals along the top of the pipe. Before returning the soil of the trench, it will be necessary to throw a few handfuls of coarse gravel over each hole. Only well ripened and seasoned canes should be laid. If green, they are apt to sprout, grow, and quickly choke with roots.

The advantage of this system is its cheapness, the celerity with which laid, and the ease with which it is laid to grade. The drawback is the short life of the cane. Nevertheless, its normal life of a few months may be extended over a number of years by drawing through a lime wash bath so as to thoroughly coat the cane within and without with whitewash. The wash should be fixed by the addition of glue, or the well steeped leaves of the flat-leaved cactus (Tuna), very generally distributed over the islands. The experimental nature of this recommendation lies in that still unknown quantity—the life of the bamboo. Canes so treated have, after four years, been taken out of the soil in an excellent state of preservation, and this may be taken as the probable reasonable life duration of well prepared bamboo.

CHAPTER FIVE

SUBSOILING

63. Use of subsoiling. This is the next step to consider in original soil preparation, and its use is indicated wherever, a few cm. beneath the immediate surface, we find a hard, compacted, water-impervious layer of soil. Its purpose is to break up this dense sub-surface, so as to permit of the free passage of air and water. Its practice is now common in all countries in connection with the cultivation of roots or other deep seated plants. Root crops in general are not successfully grown in tropical countries and, on this account, the necessity for subsoiling more rarely occurs. There are, however, other causes that eloquently call for the occasional introduction of subsoiling into our ordinary farm routine. The principal cause is due to our insufficient tools of ordinary field culture. Most of our lands have for many years been lightly skimmed just beneath the surface with the native plow. This plow, armed with a heavy wooden shoe, has glided along at a uniform



THE SUBSOILER

depth, packing the undersoil and forming a glazed, almost water-impervious hardpan. The roots of annual plants can not penetrate this hardpan, and when the plant food material in the first six or eight centimeters of soil is drawn upon exclusively, there is a rapid falling off in fertility and productiveness. If subsoiled occasionally, these lands would quickly respond with a better crop yield.

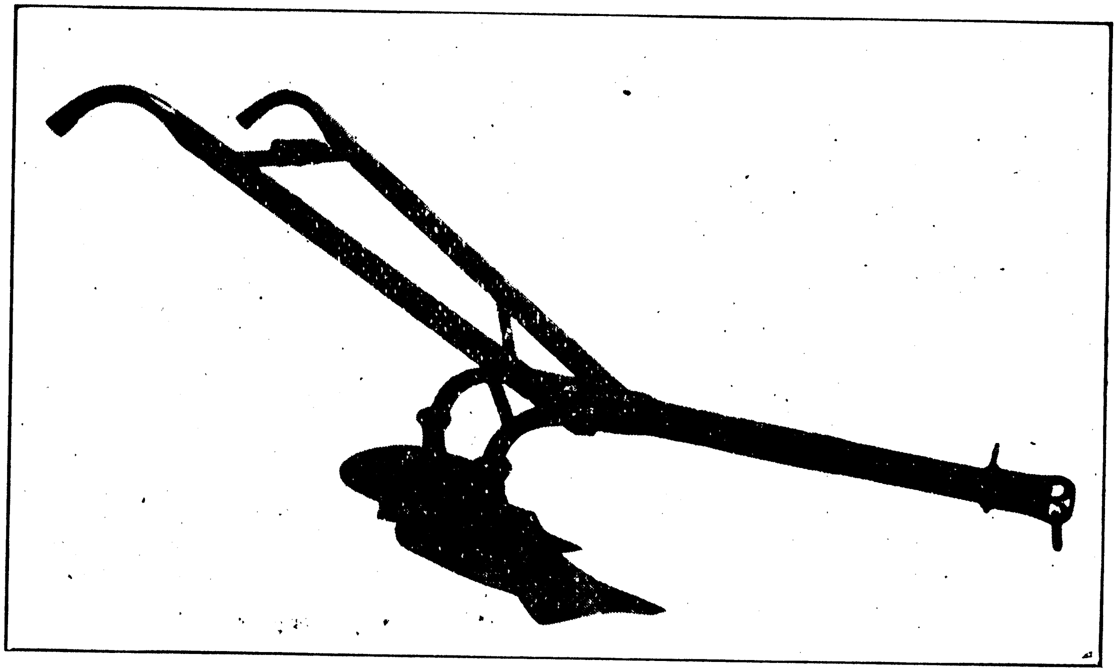
64. How a subsoil plow works. Subsoiling is effected with a subsoiler, often miscalled a subsoil plow. One of many forms of subsoilers is shown in the picture. It is an implement intended to follow in the wake of a common plow, and the office of its powerful, wedgelike cutting blade is to cut or rip asunder the soil in the furrow made by the common plow. This plow has what we call a gauge wheel, which may be raised or lowered to the depth at which it is desired that the plow shall run. The resistance that a subsoiler encounters is very great and increases with the depth at which the blade is set.

65. Use of heavy draft implements. The common Filipino farm animals are all too light of weight and lacking in strength to operate a subsoiler alone, but are easily trained to work in pairs or in fours. So handled, they can operate tools for soil breaking to a depth of 25 or 30 cm. It is necessary that the farmer should early inform himself of and be equipped with the best implements for the mechanical treatment of the soil. Some of the most useful of these are what we call implements of heavy draft; that is, tools requiring considerable animal power for their operation. Descriptions of these tools will not be given till we come to points in this story when their use is specifically called for; but this is a good place to call attention to the reason why their use is particularly called for by the Filipino farmer.

66. Time to work soil. Much of the valley land of our country is of rather heavy or stiff clays. There is only a limited time in each year when it can be worked to the most advantage. If the least bit too wet it turns up sticky and, in this state, cultivation by cementing the particles of soil together injures rather than benefits its physical condition. If a little too dry, it turns up in immense clods, that require an extravagant outlay of time and labor to properly pulverize.

The constant rains that prevail for six months and the occasional rains that occur during the remainder of the year, therefore, reduce the actual days when soil working can be satisfactorily effected to a rather small number. It, consequently, behooves the farmer to prepare every possible hectare of the farm during the favorable season.

67. Benefits of large implements. To illustrate the advantage of implements of heavy draft, let him operate with four carabaos, or four stout bullocks, a three-gang plow, each share having a 25 cm. cut, that will turn up in all a strip of land about three-quarters of a meter wide. With our slow-footed beasts, and working only eight hours each day, he can cover only a little more than a hectare of land. This is effected with the labor of one man, four animals, and with a plow, the cost of which will be about one hundred pesos. To plow the same area in the same time by native plows will require six men, six animals and the use of six plows that cost from thirty-five to forty pesos for the six. Nor is this all; the modern gang plow will do a better and more effective piece of work in going once over the ground than the native implement will accomplish with two plowings. Very many times three and four plowings with the native plow are necessary to get the land in fit



A LIGHT DRAFT GANG PLOW. EASILY OPERATED BY TWO SMALL ANIMALS.

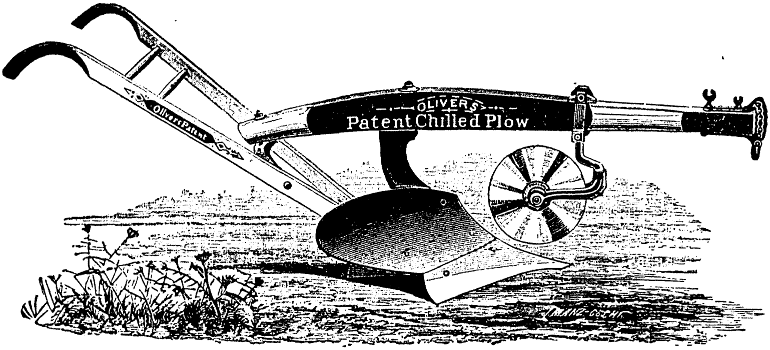
condition for planting, or as fit as a single operation with the gang plow would make it. In the latter case it would, therefore, require the labor of twenty-four men, twenty-four animals and a like number of plows, representing an outlay of one hundred and forty to one hundred and sixty pesos to accomplish the equivalent effected by one three-gang plow. Further, our climate is peculiarly favorable to the rapid growth of weeds, and the intervals between rains limited when, and without injury, we may enter the land. In that case, with weed eradicating implements of large dimensions and heavy draft, we can quickly restore to good seeding condition very considerable tracts of land. With the appliances now in use, unless the farmer be happily possessed of unbounded cattle and labor, the weeds will overtake him, and his only alternative then—as not infrequently happens—is still another plowing.

68. Need of improved implements on small farms. There is a mistaken notion abroad in our land that farm machinery of heavy draft is only to be owned and operated by the farmer who plants upon a great scale. On the contrary, the large proprietor with many laborers and hundreds of work cattle is the most independent of them. It is the small farmer, unable to hire labor, and with only half a dozen bullocks and limited lands, to whom they appeal and who, by the use of them, can quickly place himself on the plane of his more fortunate neighbor.

BREAKING THE LAND

69. Process of breaking. In original soil preparation, the first plowing of virgin land is called "breaking." From the farmer's standpoint, all land is virgin that has lapsed from cultivation for a few years and been abandoned to weeds, grass or jungle. We have already discussed the treatment of jungle or wood land, but it is often necessary to reduce grass lands into cultivated fields and this requires a different treatment. The bad but necessary practice heretofore followed has been to burn over these lands at the close of the dry season and then, after the first good rains, to plow, replow and plow again, until the grass is finally subdued,—a bad practice, because it involved the destruction by fire of a great quantity of excellent humus-forming material; a necessary practice, from the lack of the implements to properly subdue it.

70. Implements for breaking. A breaking plow, for sod lands, differs from a common plow only in stronger build, greater weight and a greater flare to the mold board, to insure a more complete and perfect inversion of the furrow slice. It is further provided with a miniature plow, a knife coulter, or a rolling coulter, attached to the beam a few inches in front of the plowshare. This preliminary apparatus cuts an advance path through the grass roots, and greatly reduces the resistance that the plow proper encounters.

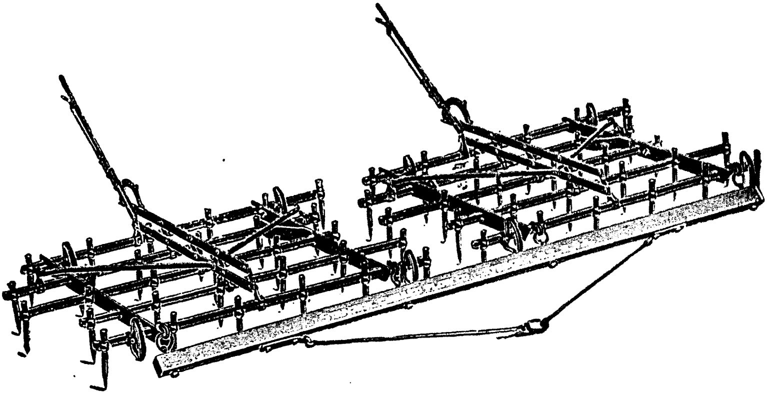


A SOD BREAKING PLOW

They are generally made to cut furrow slices of 30, 35, and 40 cm. and, according to the depth they are set and the toughness of the sod, require two, three or four animals for their operation. Sod lands properly plowed once, and the surface then fined and smoothed down, is in the best receptive condition for planting a corn crop. In fact, it may not advantageously be plowed again till all the sod and trash have decayed and become fully incorporated with the soil. This is sometimes a matter extending over two or more months, and the provident farmer, unable to put his land into the best possible condition at once, dedicates it temporarily to corn instead of weeds.

71. Breaking sod lands. When the growth of grass or weeds is very heavy, it is customary to attach a bit of stout iron chain to the plow beam as a drag to precede the plow. This throws down the grass and insures its complete burying. This plan of original soil preparation, if performed about the close of the rainy season, is the most assured way of completely eradicating "Cogon," the most difficult weed we have to contend with in these regions.

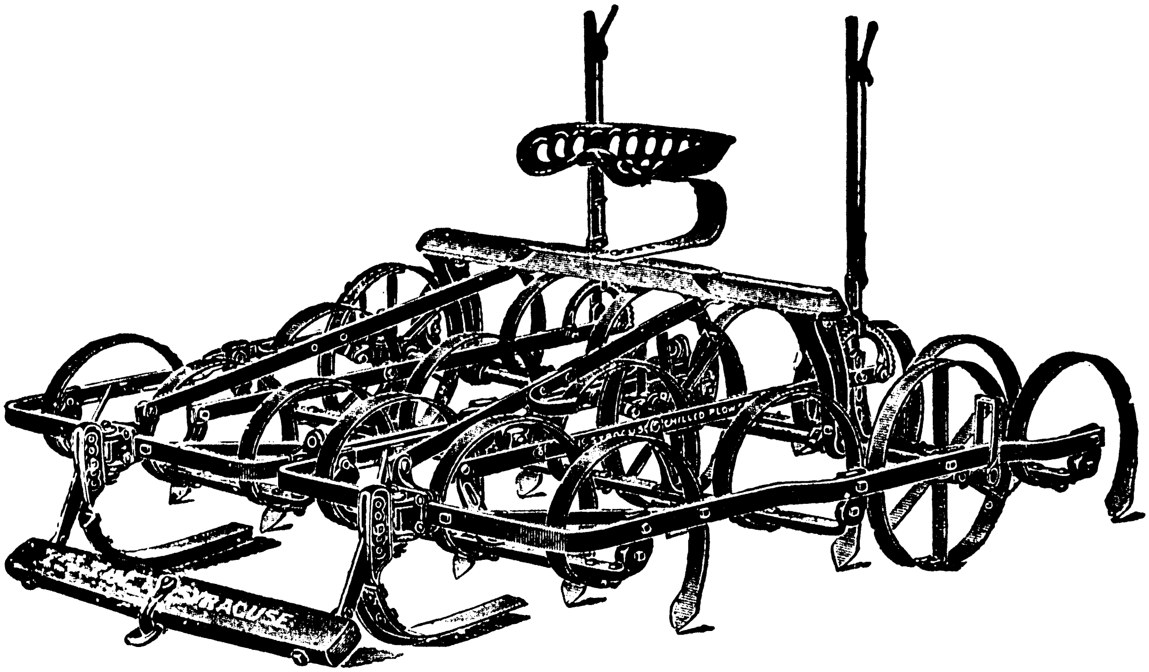
72. Need of harrowing. The subsequent step in preparation, harrowing, scarifies the sod roots, tears the protecting soil away from them, leaves them exposed to a hot sun, and insures the almost certain extermination of the enemy. The native plow in cogon lands does little more than stir and cultivate the plant, and stimulate it into new growth. The harrowing given covers up a few tops, but tears out and exposes, with a good chance for new growth, any that the plow succeeded in burying.



SMOOTHING HARROW

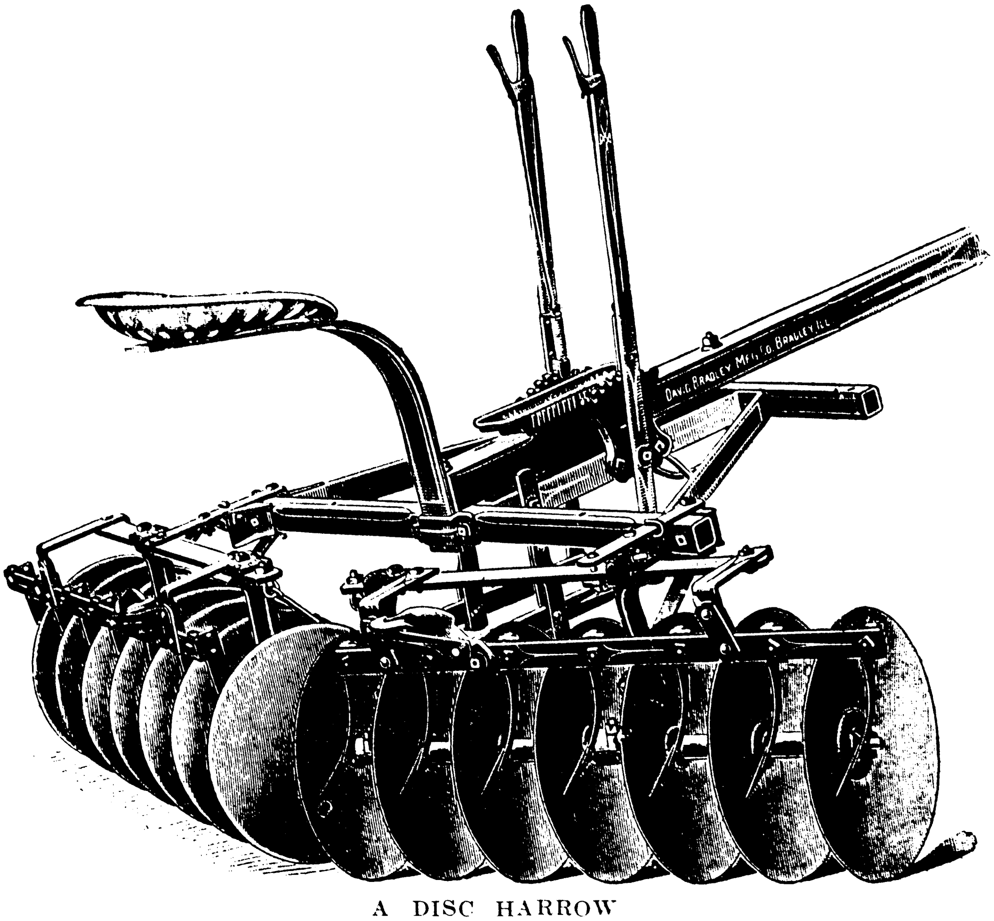
There can be no cropping to corn but continuous and seemingly endless plowings until, little by little, most of the roots are dragged to the surface, collected by hand and destroyed by burning.

If, after plowing with a sod breaker, the texture of the land is such that it breaks up readily, it is best brought to condition for immediate planting with the smoothing harrow. These implements, of the most approved patterns, are made in sections that are joined by hinges or universal joints that allow the different parts of the harrow to adjust themselves to any surface inequalities. They are fitted with levers that will allow of the teeth being set vertically, at a slant, or perfectly flat. For the best reduction of a sod root surface they are set at a slant, and the machine passed over the land in the direction that the furrows lie. This process involves more passages over



A SPRING TOOTH HARROW

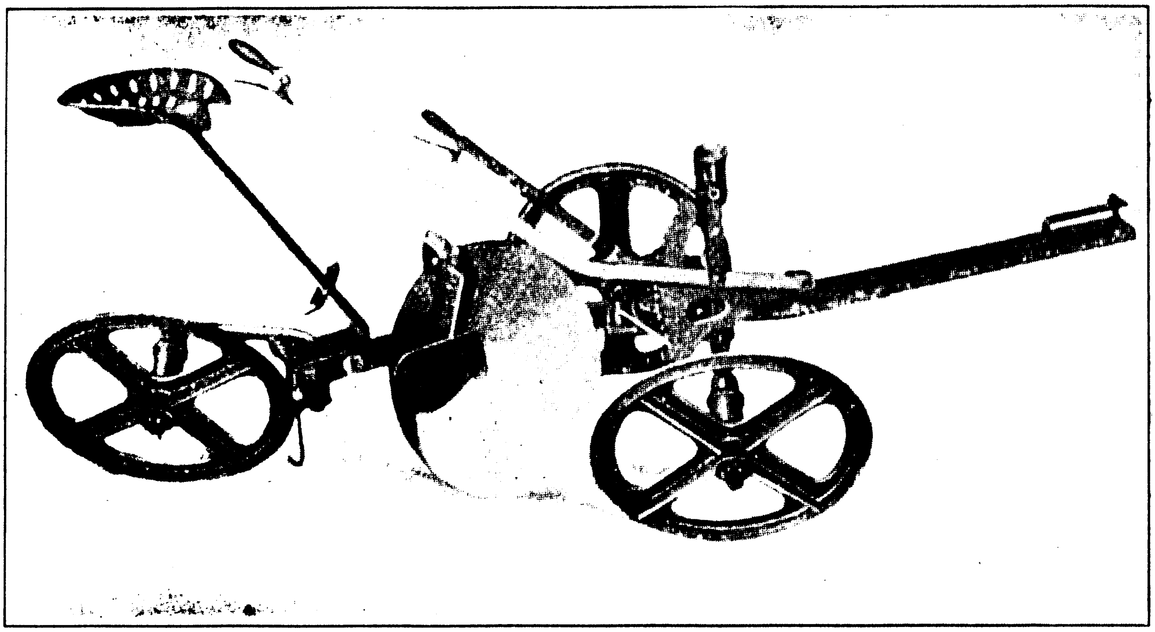
the land than if we were to set the teeth vertically and cross the furrows at right angles. Unless, however, the plowing had been deep and thorough, this latter method would be sure to tear out and bring to the surface much of the sod the farmer has been at such pains to bury.


DAVID BRADLEY MFG. CO. BRADLEY, ILL.

A DISC HARROW

73. Discing harrows. If sod is on tenacious land, and turns up in clod-like masses, then the best implement at our command is the disc harrow. Disc land working machinery has two forms of motion. It both cuts and scrapes. The disc will pulverize clods that will resist all other forms of land working machinery except heavy rollers and is undoubtedly, for this purpose, the machine of most practical utility that has been devised in many years.

It sometimes occurs that land other than sod land has been plowed and harrowed; and yet the conditions of climate or season are not propitious for the immediate sowing of a crop. At slight expense these lands can be kept in admirable condition for seeding at the proper time, by running over them with the smoothing harrow previously described or with a spring-tooth harrow.



A MODERN SINGLE DISC PLOW

The spring-tooth harrow acts both as a digging machine and a pulverizer, and completely breaks up small clods and lumps. These different implements will keep down weeds, and keep the land in constantly bettering condition until the time for planting has arrived. Like the plows, implements of good size and weight will perform the most satisfactory work.

The disc harrow will require the use of four of our ordinary work cattle. The spring-tooth may be worked by two large or three small animals, and the smoothing harrow by one, two, three or more, according to the size and number of sections it contains.

PART II

CHAPTER SIX

THE PLANT

74. Life history. The plant must be studied in relation to its life history; its growth, reproduction, and death. And it may, with advantage, be studied in relation to many other things whose importance does not appeal to us so strongly as these three. Its growth covers the whole field of health and disease and the conditions that lead up to each. It may require no experience or scientific training to say that "such a crop is a good one," "such is a failure," or "such a tree is diseased," or "such is in good health." These are self-evident facts, but the remedy for them is only obvious to him who, knowing the causes that bring about the condition, is able to apply the corrective.

A growing field of tobacco may turn yellow in midseason. It may be due to excess of water or to need of it, to a deficiency of proper plant food material, to the presence of injurious agencies in the soil, or to the influence of two distinct forms of disease. How manifold the advantage of the one whose knowledge may discriminate the cause and enable him to obtain immediate relief! Plant life is a cycle that begins and ends with a seed, and the seed, therefore, is first to command our attention.

75. The seed. Many seeds contain within themselves a more or less perfect miniature copy of the plant from which they sprang. Sometimes the unaided eye can distinguish the leaves of the young plant neatly and compactly folded within the seed. More frequently it is undeveloped, and sometimes a minute point (called the embryo), so small that it may not be distinguished without the aid of a magnifying glass. Every perfect seed contains this embryo and no seed in which it is wanting will grow. It contains rich and nutritious substances that are much sought by weevils and other insects. Seeds in which a minute hole has been drilled have most times had the embryo eaten out and are consequently worthless for planting.

The embryo of seeds is endowed with that vital and not easily explained function that we call life. We may *hear* life, or its manifestation, with our ear close to a field of newly sprung grain or grass. We may *see* life, or its manifestation, in the daily and hourly changes in a growing leaf. With the aid of a microscope and some simple chemicals, we may approach still closer to the mystery and see the living agent of growth, streaming up and down through all growing parts of the plant at its incessant and tireless work of building up or breaking down, as may be required in its constructive work. Beyond this, successful human investigation has not gone, and this final, this ultimate agent we call protoplasm, or life. This life abounds in the embryo of the seed, but is dormant; it sleeps until affected by certain quickening influences.

76. Seed vitality. If we could imagine a temperature that never varied, a place that was neither extremely warm nor cold, an atmosphere that was free from all dampness and germs of disease, we would have a place in theory where the suspended life—the sleep of seeds, like that of the enchanted princess—would go on forever until awakened, not by the kiss of the prince, but the warm kiss of the sun and the moisture-laden breath of the clouds.

77. Germination of seeds. In the tropics the essentials to seed sprouting are air and moisture. One is as necessary as the other, and that both are required is determined by a simple experiment. Put some corn seed in a small bottle, fill to the brim with water and cork tightly. In a few days it will be seen that the seeds have discolored and are decayed. Small quantities of air are found in water. It is almost impossible to pour water into a bottle without imprisoning some. Minute bubbles, or a film of air will cling to the seeds, and this small quantity will sometimes suffice to set up the feeble and partial sprouting of a few seeds.

Next take a perfectly dry bottle, fill nearly full with corn, stopper it with a plug of cotton wool over which is poured a layer of powdered charcoal. The bottle is then tightly corked. In this process, the air has been bottled up with the seed and with it the moisture that it contains. But the absorbents we have introduced will withdraw most of this moisture, and the seeds will remain forever unsprouted.

Finally, place a few grains of corn in the cover of a common cardboard pill box. Put this in a saucer containing enough water to wet the box but not enough to flow over and cover the seeds. Over the box now invert a tumbler, to prevent evaporation of the water, and in from fifty to seventy-two hours the seeds will be sprouting freely. The farmer makes practical application of these facts by carefully storing away from both air and dampness the seeds that he desires to carry over for another season's planting.

78. The seed coat. The nature of the external covering of the seed has much to do with its vitality—i. e., its length of life—and is often a matter of lively concern to the planter. The seed coats of the cacao and mangosteen fruits are as thin and tender as a baby's skin and afford but poor protection to the embryo within. Moreover, they are covered with particles of sweet gumlike fruit pulp that adheres so closely as to defy complete removal without injury to the seed.

This pulp is alluring food for minute plants whose still more minute seeds are floating in the atmosphere. If they touch these fruit seeds they rapidly develop into the plants we know as moulds and mildews. Their roots, or the organs that serve as roots, strike into the embryo, and its death often occurs within a few days. This knowledge we utilize by sowing such seeds as soon as their fruits become ripe. They are subjected at once to the influences of air and moisture, to hasten their sprouting before they are attacked by other organisms. Seeds so badly protected we describe as of short lived vitality. We may treat them so as to avoid the attacks of other organisms, but their lack of a good coat makes them sensitive to changes in the temperature and to moisture in the atmosphere—changes sufficient to bring about death more easily than germination.

Other seeds of short vitality are provided with thin seed coats or are heavily stored with oils or resins that are injuriously affected by great heat in combination with a humid atmosphere. This sets up chemical changes, processes that are attended with a further increase of heat which is sufficient to kill the embryo. Lettuce, corn, cotton, and the seeds of some rubber trees supply illustrations of this class.

Others are provided with hard, or hard and highly polished coverings. The castor oil bean, scarlet prayer bean, seed of the chico and of seguidillas are good examples of these. The castor bean, although rich with an oil that is sensitive to the influence mentioned above, is so well protected by its polished seed coat that it is much longer lived than the equally oily cotton seed, covered though the latter be with a thicker but rougher and more porous structure.

Some seed coats are so tough and dense as to be almost impervious to air or moisture and often remain in the ground two full years before they break down enough to admit these life-giving elements. The caoang and the buri palms that we grow for the making of fiber, tuba, or sugar have seeds of this character.

79. Seed diseases. Some seeds (palay), smooth to the touch, are nevertheless furnished with fine lines or channels to which moisture tenaciously adheres and favors sprouting when planted. These same grooves afford harbor for some of those minute disease seeds of which we have previously spoken. They, too, like the moisture, and, when the rice seed starts to grow, they also sprout, strike inward, and live upon the young plant. It grows apace with its doomed victim, making no injurious demonstration until the moment when the rice plant's labors are to be crowned with success. Then the enemy discards its disguise, breaks from the stems where it has lain concealed, and virulently attacks and destroys the forming heads of grain.

Such is the brief story of what we call a grain "smut," and the farmer who has followed its life course will have learned that the enemy can be scotched in its dormant state, while asleep upon the palay seed, and at no other time.

CHAPTER SEVEN

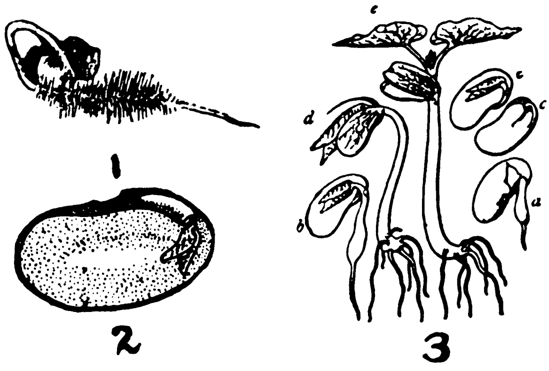
THE PLANTLET

80. Likelihood of death. When the embryo, under the quickening influence of our warm air and moisture, has first broken into actual visible plant life, it is most times more helpless than the infant young of any animal unless it be of the human.

Of the myriads of seed that fall every year upon a given piece of land, it is quite within reason to say that not one in one thousand ever lives to sprout. Still more conservative is it to say that, of every one hundred that sprout, not more than one ever grows up to the fullness of plant life. Under an old coffee tree, after a long period of wet weather, one will often find hundreds of vigorously sprouted young coffee beans and, a month or two later, it is sometimes difficult to find one! For years the ground has been packed and hardened by the feet of those who have gathered the fruit, and the tender root of the young plant, unable to pierce the hard substance, withers away and dies. Countless other seeds in the open country are often swept out of existence by a sudden exposure to a hot, bright sun, before their primary rootlet can strike into the soil. So enormous is this loss that Nature has devised many schemes to lessen the evil. Some seeds she has provided with sharp awns or points, to help them stick into the soil. Others she has equipped with perfect corkscrews, which uncoil when wet, and the act of uncoiling twists the seed into the soil. Others she has provided for by making them of tiny size. The merest film of the dust that flies in dry weather is sufficient to cover the seeds of *pasao*, or of the ubiquitous purslane, and so assist its foothold in the soil. Others, like the coffee and the cocoanut, she has provided with long lasting stores of food, upon which the young plants may subsist for many days in the case of the coffee, and for many months in the case of the cocoanut.

These foods, like mothers' milk, are all ready at hand for the use of the helpless plant infant until, at the moment when its roots are fairly planted in the soil and its leaves begin to expand in the air, it starts afresh on a new and independent phase of existence.

81. Depth of planting. In farming, we pattern after some of Nature's processes, and improve on others. In the sowing of small seeds we plant them as she does shallowly. If we cover such small seeds as jute, linga or lettuce with ten or twelve centimeters of soil, the tiny sprout is crushed by the weight of the overlying earth. If we plant very large seeds much deeper, they will often fail to sprout for want of sufficient air; for, the deeper we go in the soil, the more compacted it becomes and the smaller the supply of air.



1. Seedling of radish showing root hairs.—2. Section of bean showing the embryo.—3. Development into a young plant.

Nature can only soften her seed bed with rain, and sows a million seeds in hopes that a thousand may find a site congenial to their growth. The farmer makes *all* of his seed bed congenial and sows a thousand seeds in expectation of raising a thousand plants. Sometimes realization does not keep pace with anticipation. When it does, he has become a good and successful farmer.

82. The root. The root of the newly sprouted seed quickly seeks shelter within the soil. *Why* roots grow downward into the soil is a question not yet very clearly settled; but the thing that most deeply concerns us is the fact that some go straight downwards, and others spread out mainly in the surface soil.

Fruit, nut, and forest trees, as well as most plants whose life extends over several years have the first described kind of roots. Exceptions to this rule are the cocoanut, all palms, bananas, etc. All grains, and grasses like teosinte, corn, rice, bamboo and sugar cane, have matted, spreading, superficial root systems. The importance of a knowledge of these differences, and its effect upon farm operations, will come home to us when we further consider root functions.

Root growth is effected by the agent that we called protoplasm, and that is ceaselessly engaged in the building up of tiny cells which constantly add to the thickness of the root. But the greatest activity of this life agent is confined to the extreme tip of the roots. Here it piles cell upon cell in rapid succession, with the result of driving the root further and further into the soil.

The root tip itself is generally tough and quite callous and its chief office seems to be to blaze a path for the extremely tender and delicate root hairs that follow closely in its wake.

83. Root hairs. Through these tiny structures enters all material that builds up the plant, except the carbon that is taken from the air. When one considers that an ordinary banana stem with its leaves will weigh quite 25 kilos, and that of this probably no less than 21, perhaps 22, kilos are pure water, and that every drop of this water has been taken into the plant through these root hairs, we may realize the magnitude of their work and the importance of their being at all times, like any other machine, in the best of working order.

By means of a simple experiment, we may disclose the hidden development of a root in a most graphic manner. Take two small panes or squares of window glass and upon one place a small lump of well moistened soil, free from pebbles. In the midst of this place a grain of palay, lay the other pane on top of this and apply pressure enough to make the grain of rice touch each of the glass surfaces. This will flatten out the wet soil in a thin film. Now tie the glasses together, hang up where they will receive light, but no direct sun, and pour daily a few drops of water between the panes, using care to see that the soil is kept moist but not fluid. In a few days the roots will issue, apply themselves closely to the surface of the glass, and enable us to watch their development and the delicate and beautiful structure of the root hairs.

The development of a vertical root system is not so often within the command of our vision, but is sometimes disclosed along river banks that have been eroded in flood time, leaving the roots exposed.

Sometimes the stone walls and ancient buildings of our towns afford excellent opportunities to see this kind of root development. On these the seeds of wild figs often lodge and sprout. The little dust that has accumulated there supplies insufficient food for the growing plant; the roots cannot pierce the hard stone, so they turn downward to the soil, clinging for support to the wall.

Every crevice they encounter they explore, and the root hairs take up, from the decaying matter and soil that has gathered there, enough nourishment for the plant until its roots finally reach the soil.

84. Application of knowledge of root system. The farmer makes practical application of a knowledge of root systems in the operations of soil preparation. If preparing to plant an orchard of orange trees, or a plantation of cacao, he digs a hole many times larger and deeper than is required by the young tree at the time of planting. Still more, and in the best practices, it is now common, after the hole is dug, to explode a charge of powder in the bottom, to still more deeply tear and rend the soil asunder. It is obvious that the looser and more permeable the underlying soil, the easier of penetration by those roots whose tendency is deep downward. That they will live, grow, and produce their fruits without this preparation is self-evident to one who sees them growing wild in Nature's garden. The gain of proper preparation lies in more rapid growth, earlier fruitfulness, a greater vigor and ability to resist disease, larger and better crops—in short, more money returns.

85. Deep vs. shallow roots. Plants having a superficial root system, on the contrary, require, in general, but shallow soil preparation. To this there are some notable exceptions, of which the cocoanut and the sugar cane are good examples. The great size to which this grass and this tree grow requires that, to secure a good anchorage in the soil, their roots have an opportunity to descend downwards as well as laterally; hence we plow more deeply for those plants than for rice or corn. The tree or deep rooting plant, whose life may extend over many years, may explore the deeper soil levels at leisure selecting at pleasure those food materials that best meet its requirements. The grass, grain or cereal, that must accomplish its life history—must run its course —in three or four brief months, must literally "make its hay while the sun shines." It has no time in which to forage far afield for its needs, and its roots will ramify freely in a surface that is kept open and mellow. Here once more a study of the root system results in practical utility to the farmer. The land of his orchard he may plow deeply and well, for the benefits that we have seen come from good, deep tillage. But he may not apply the same treatment to his other crops. They, too, must have the soil kept open and receptive to the influence of air and moisture, but it must always be done with tools of shallow cultivation. If not, he would lacerate and destroy those root hairs upon whose number and well-being rests the success or failure of his planting.

CHAPTER EIGHT

THE LEAF SYSTEM

86. The work of chlorophyll. By a process of cell upbuilding, in principle very similar to the growth of the root, the leafy parts of a plant are pushed upward. With it, however, a new element commands our attention, that plays no part in the economy of the root. This is the coloring matter that gives the green tint to nearly all plant life.

This green matter may be likened to the stove in a kitchen, for it holds the fire that cooks the food. It has the property of absorbing some of the rays of light, and light, be it direct sunlight, daylight, or even electric light is like fuel for the plant in the preparation of its food, just as sticks of wood or pieces of coal are fuel for us. In this miniature kitchen in the leaf the life substance which we call protoplasm is the cook, the rays of the sun are the fuel, and this green matter which is called chlorophyll may be likened to the stove which holds the fuel. These three combined do the work of preparing the food without which the plant would go hungry.

The root is a good provider, but it can make no food, and without food it could do no work. But this energetic little protoplasmic cook works over the raw material that the root sends up, seasons it to taste, and sends it down again in such abundance that the root, in order to avoid serious dyspeptic troubles, stores much of it away in special, fleshy growths. Those fleshy growths we variously call bulbs, tubers, and corns. It is by this process that the farmer secures gabi, ubi, camotes, onions, and many other good things.

87. Growth not dependent on green color. That phenomenon which we call growth is not influenced by this green color. Plant a potato in a warm, dark cellar and it will make long, colorless shoots and leaves; but, if it is dug up, roots will be found in abundance, but not a vestige of a tuber will be found on its underground stem.

From this we may surmise that this green material is very essential to the farmer and that, according to its abundance, the plant will produce for its own needs, and the surplus may be garnered by the planter. This green matter will not grow or live out of the sunlight. Invert an empty box or barrel over a weed or any other small plant and, in a few days, remove it and observe that the leaves have turned yellow or white. The green coloring cells have all died. If exposure to the sunlight is gradual, in a few more days the green color will be restored.

88. Experiment with shading. If you carefully measure out a square meter of land and plant in the center thereof a single grain of corn and (assuming that other conditions are good), in three months, from the single stalk that has grown, you may harvest two big, plump ears. But the stalk has actually only occupied twenty square centimeters of the land where it sprang from the soil. There is, therefore, no reason why we should not plant five hundred seeds, raise five hundred stalks, and harvest one thousand good ears, from the same meter of land! Let us try it, and, although the thousand seeds should spring as well as the one, when a few inches high, the shade on the lowest leaves will become so dense that no green color can form, and they begin to yellow. In a little time more, the shade will affect so many of the leaves that those that remain on top are unable to supply any more food than is required by them and their ailing brethren, and they have no surplus stores to send down to the root. When the food supply of the root is cut off, it sulks and refuses to work, and in a little more time the thousand plants die, without ever producing one thousand or any number of ears.

The practical application of this illustration is in such a system of planting and culture as will insure to the plant and to its leaves ample room for their best growth and development, in order that its supply of green coloring matter may always be kept at the maximum. Many of the scanty cocoanut crops and wretched corn yields that our farmers harvest are due to crowded planting and insufficient green matter for the manufacture of plant food.

89. The stem. The stem, whether it be the stalk of a grass or the trunk of a tree, concerns us nearly, as upon its well-being much of crop success hinges. Through its length the necessary sap travels upwards to the workshop of the leaves there to be made over into food for us. It is of practical utility for the farmer to know something of the way that the sap travels upward through the stem of most plants and returns. In its upward passage its current is within, confined to what we call the sapwood—the newest and tenderest layers of young wood or tissue. On its return it travels still nearer the outside of the stem, in a narrow zone, close to the bark or skin. It is on its return downward that it is utilized by the protoplasm in building up new cells between the bark and the sapwood, which accounts for the stem swelling in size.

90. Knowledge of sap movement. A knowledge of this principle is useful in "ringing" a tree that you wish to destroy, and which is too large to fell. If the bark only is cut through, the sap will continue to flow upward, and the tree will not die, sometimes for one or more years, or until the roots die for want of the nourishment that can not return to them through the inner layer of the bark. Sometimes the wound will even heal over and the plant recover. If, however, the bolo is laid deeply enough to cut quite through the tender sapwood, in a few days the leaves will fall and the plant dies.

From this, too, we learn how serious is any injury to the stem of a plant in the ordinary operations of cultivation, for every wound or abrasion means the loss of so much surface—so many highways blockaded against the free ascent and descent of the sap.

In the grasses and grains growth occurs somewhat differently, the increase occurring through all parts of the stem that are not hollow.

91. The leaf. To the farmer the leaf is the surest index to the condition of the planted crop. Given a good leaf development and, in most cases, he is assured of a good crop. If asked what constitutes a good leaf, we would answer, one showing turgidity and a rich green color.

Turgidity is only to be explained by distension, a word nearly as big, but is well illustrated in a newly inflated gas bag. When a leaf is turgid, all its parts are swelled and gorged with food. Plants in good condition are always gorged with food, and the result is shown in strong, rank growth. Plants, however, are like humans and can be overfed or over stimulated.

Abundant water to the root will make the leaf turgid. When the root receives an excess of water and the atmosphere is so humid that evaporation ceases, the leaves, like an overfed person, lose their activity. Loss of activity always means loss of growth and, if this loss of growth occurs at any time except when its cycle of growth should be completed, the result is the same as disease, and sometimes ends in death.

The same thing occurs when the soil is overloaded with good things, or barren of all food. In one case the plant can not digest the rich supplies taken in by the roots; in the other it starves for want of them. The result is the same in each case, and is shown in flaccid, pale colored leaves.

92. Leaf disease. The yellowing leaf in the plants we grow upon the farm is always a sign of ill health, and it is vital to the farmer to know the cause. One year his sugar cane may turn yellow and a dressing of manure will quickly restore it. Another time it may act the same way and a dressing of manure may make it worse. It may be that in the second case the ground was sodden, and that the opening of deep furrows down the rows would have drawn away the excess of water, permitted aeration of the roots and the restoration of the crop.

The farmer studies the actual wants of the plant he grows. He may put a thousand kilos of manure upon a field of one hectare and double his crop; but he must not argue that, if he puts on two thousand another time, the crop will double once more. The result will most times be the loss of the money value of the extra manure, and no better, if so good, a crop. The wants of the leaf are the wants of the whole plant and, as surely as he aims to so cultivate, drain, water or manure the plant so as to produce a good leaf development, so sure is he of good crop returns.

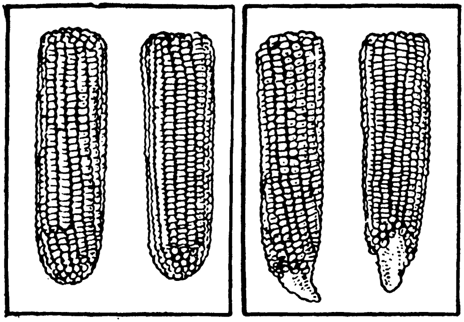
93. Carbon and the leaf. It was mentioned further back that the leaves breathed in large quantities of carbon in the form of a gas. This carbon, next to water, makes most of the weight of all plants. How much of it enters into all grains and seeds that we use, you may have learned from trying to brown coffee and forgetting to remove it from the oven at the proper time. Instead of the beautiful, browned berry, you find a charred mass that is nearly pure carbon.

The very complex chemical processes by which the gas of the air is converted into this solid material, while of fascinating interest to the student, does not appeal of necessity to the farmer. The carbon in the atmosphere is the one element in plant economy positively beyond his power of control. The most that he can control is the leaf. If he maintains this at all times at its best, it will take up, without intervention on his part, all the carbon it requires for the fulfillment of his ends—a good crop.

CHAPTER NINE

FLOWER AND FRUIT

94. Seed selection. All seed-producing plants have flowers, and it is essential that one should know a little about them and their functions, if he is ever to practice "seed selection." Without the practice of seed selection no farmer, particularly in the Philippines, can ever attain to the greatest possible success in his craft. In many countries there are farmers who do nothing but rear seeds for planting purposes and, until there are such planters here, we must do our own seed selection.



SEED SELECTION. THE EARS ON LEFT SHOW THE IMPROVEMENT MADE BY SELECTION

The flowers of many plants are conspicuous and showy, as in indigo, cotton, sincamas, etc.; but in some plants, like rice, they look not unlike the grain itself until, upon near examination, you will see the little yellow anthers, as they are called, protruding from the lower half of the most external of the grain covers.

95. Sex in flowers. Flowers, like humans and animals, have sex—are male and female—and, precisely like animals, will not produce offspring unless the influence of the male be brought to bear upon the female.

Commonly, the two sexes are upon the same plant and united on one flower. Tobacco, linga, and palay are examples. Sometimes the sexes are on different flowers on the same plant. Corn is of this nature, the female flower being where the "silk" springs from the cob, and the male flowers being the pretty tassels that wave like plumes over the corn field. Still others, like the papaya, have the male flowers entirely upon one plant, while another produces nothing but females.

96. Pollination. At the time of the fullness of flower growth, from the male organs issue fine, dust-like bodies that, by the aid of winds or insects, find lodgment on the female organs of reproduction. This fine dust has the effect of making fruitful the female, and results in the formation of the seeds, grains, berries, or other fruits that the farmer seeks.

Without this union of the sexes there can be no crop, and a simple way of determining it is to strip the stem of a young female papaya of part of its flowers. Do this, so as to leave bare a bit of the trunk above and below the remaining flowers. Draw tightly about this bare part of the stem a piece of very loosely woven, thin cotton cloth, slackening the cover where the flowers are reached, so as to bag them very loosely. The fabric must be thin enough to admit light and air, but not of so coarse a texture as to admit insects, nor the dust from the male flowers. If proper precautions have been taken not a single fruit will set, and the flowers will finally wither and fall into the netting.

97. Hybrids. Many farmers, who are enlightened in their craft, make common use of this knowledge to create new and better varieties of plants. When they attempt this, they carefully remove all of the male organs of a flower in its earliest stages and before the powdery dust has ripened. Then they protect or isolate the remaining female parts with a netting or cover like the one described above; then, when the dust has developed on some other flower of some other plant, they transfer some of it to the female flower that has been isolated. The protecting cover is then restored and allowed to remain till the seed or fruit has formed. The cover is then removed. When this seed or fruit has ripened, it is usually similar to the fruit that the female generally produces; but, when sown, from it springs a new race—a mestiza—with resemblances to and differences from *both* its parents.

The practice of this art is called hybridizing, and those who have attained the greatest success with it are those who have most deeply studied plant kinship.

Plants, like human beings, are all related to each other; but some, like human beings, more closely than others. Hybridists have accomplished the best results in working with plants very closely related to one another. It is not improbable that an *ate* and a *guabano* could be successfully hybridized, but we may never marry a lansone and an orange with any success, or with the prospect of rearing a new or different fruit.

Farmers have successfully married two varieties of corn. A certain kind of corn may ripen its grain a week sooner than any other variety. At the same time, it may produce a very small ear. Another may take much longer to ripen, but perhaps produces large, fine ears. If the two are carefully hybridized, from the seed produced, we are apt to have some plants which will ripen early and also have large-sized ears.

The apprentice at this art will have many disappointments. He may rear many thousands, none of which will be any improvement upon or so good as either of the parents. His work is one of infinite patience and the result of well thought out plans. There is no royal road to its mastery except through practice and study and, although chance—luck—is an element of the result it is so small as to be measured in fractions of one per cent.

98. Exhaustion after seed production. When the flower has performed its office of marriage it dies, and, with it, at that time, occurs the gradual death of many farm plants. The end of the flowers has been to produce fruit or seed, and to accomplish this the plant dedicates all its reserve forces and stores of food supplies. So intense is this effort that, in short-lived plants, their death after fruiting seems to be due to sheer exhaustion.

The yellowing of rice and corn leaves, that shows when the flowers are dying, begins from the ground. The yellowing that comes from disease may appear first, in the top or uniformly throughout the plant. The first is the result of a purely natural cause. Nature has effected her end and there is no longer occasion for the plant to live. Therefore, up to the very hour of flowering, we may see the usefulness of such farm operations as will help to effect a big and strong flowering, as most times this is the precursor of a big and strong crop.

99. The fruit. This is the end for which the farmer has striven. It was at this point that we started (for to the farmer the seed and the fruit are practically one), and it is here that we end.

To the hybridizer an accurate, scientific knowledge of every detail of a plant's structure is most essential. To the general farmer, however, a study of the forms that the fruits take is of more practical utility than a knowledge of the various parts of a flower. He has not to read this or any book to know that some seeds are surrounded with a fleshy pulp (the mango, the santol, the cacao, and the guava will serve to illustrate this kind); that others, like cotton, are clothed with a dense, fibrous wool; and others, like palay, corn, and the peanut (mani), with one or more loose or close fitting dry husks or skins.

The farmer should familiarize himself with the various forms that fruits assume, because they are essential to the process of intelligent seed selection. In many countries he is largely independent of seed or fruit selection. It is done for him by specialists whose profession is to maintain seeds and fruits at their proper standard of excellence, and not permit them to grow worse.

100. Degeneration. In our tropics this is not done, and every farmer must and does save his own seed instead of buying it from those whose specialty is its production. In consequence, in these tropics, field and orchard fruits have degenerated. This means that, in some cases, they have reverted or gone back to the wild or uncultivated forms from which they first sprang. This generally means something less productive, or inferior to the race that the painstaking grower has once built up, and such a result is a misfortune that must appeal to every one who farms.

We have already considered the seed in regard to its structure and behaviour when planted; but it still remains to be examined in regard to selection for the planter's use. Without this question being understood and practiced by the Filipino farmer, he can never hope to obtain the best results for his labor.

It is not enough that he should select the biggest nut from a cocoanut tree, or the longest or largest spike from a rice field, and save these for seed. In the case of the cocoanut, he should learn something of the history of the tree from which he takes the fruit for planting. If on his own property he should watch the behaviour of the tree, and ask himself questions: Does that particular tree bear a good crop every year, or does it some years produce a scant crop or none? Are the nuts uniform in size, or a few exceptionally large, and the rest dwarfed or imperfect? Are the meats always thick and solid, or are some thin and pasty?

101. Heredity. If these questions are all favorably answered, the cocoanut planter is amply justified in paying a high price for the fruits from such a tree for seed. The reason for this is founded in a natural law that like produces like. There is a tendency in Nature to reproduce in the children the traits of the parents. This should be called an inclination, for it is not a universal law. Sometimes, on the contrary, very objectionable traits appear in these carefully selected children; but its utility to the planter lies in knowing that, if he practices this selection with care, a very large per cent of the fruits that he plants will inherit the good traits of the individual tree from which they were selected.

Think how great the advantage to him who, knowing these principles, puts them in practice, over him to whom all cocoanuts look alike!

Go over a rice field and learn to be observant. You will notice plants that are more robust than their fellows; others not only with better spikes, but with a heavier load of well formed grain. Save the heads from these plants and another season plant them apart, where no other rice is planted and where there is but small danger of their becoming married with any kind other than their own. From this little planting select not only the best, but those which most resemble the form that you selected last year.

If you continue this process for a few years, sowing each time only the selected grains, the majority of the field will produce plants and seeds like your original type. This is called *fixing a variety*, and is a method within the reach of every intelligent farmer.

CHAPTER TEN

PROPAGATION

OTHER METHODS OF INCREASE THAN FROM SEEDS

The rapid increase of plants is effected in other ways than by seed sowing.

102. Seedless plants. Some plants, like most varieties of bananas, fail to produce seeds. Others, like many kinds of bamboo, are known not to produce seeds except at intervals of very many years. Most fruit trees not only take long years to bring seed to maturity but, as the offspring are inclined to vary somewhat from the parent, their reproduction from seed is seldom attempted.

103. Offsets. Gabi and ubi produce both seeds and underground offsets from the root, and it is found a more rapid and profitable process to plant these offsets than to sow the seeds.

104. Suckers. Bananas, bamboo, and sugar cane throw up abundant suckers from the root crowns. These suckers are identical with the parent plant, and, when separated and planted out under proper conditions, are capable of becoming independent, self-sustaining individuals.

Our most useful yams, camotes, tugui, and namé seldom perfect seed, but all are easily multiplied by planting small pieces or cuttings of their vines; and camote-ng-cahoy *(casava)* is increased by replanting the small tubers or cuttings of the woody stem.

105. Cuttings. A cutting is a small section of the stem or branch which under the same conditions that influence the sprouting of a seed is capable of development into an independent plant. It is an indispensable essential that every cutting should contain at least one bud or "eye," as the small, growing point found in the axil of the leaf is called. This bud, as we have seen, is the embryo of a young plant as much as that found packed within the lobes of a seed, and the planting of any cutting in which it is wanting will result in failure.*

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*In a few instances leaf and root cuttings are capable of development from "points" which, after all, are probably imperfect or undeveloped buds. The exceptions are few and do not apply to plants in common agricultural use.

106. Nodes and internodes. On examination of a stalk of sugar cane, one or more buds will be seen imbedded at the base of the old leaf scars. These are called the nodes. Then follows a longer, smooth section, free from buds, called the internode. The student should cut a section of each, plant them, and determine for himself the truths stated above.

In theory, every cutting containing a bud is capable of making a plant, but in tropical farm practice, its application is confined to the plants we have named, and to those that readily emit roots before the stores of reserve food within the cutting are exhausted.

In hot, dry weather, it sometimes happens that a cutting pushes into leaf growth before root development has begun, and, having no means whereby to regain the moisture lost through evaporation soon perishes. For this reason cuttings are planted in the rainy season when moisture, soil and atmospheric, is greatest and evaporation least. As a further aid to establish cuttings that are slow in emitting roots we shelter them from the direct rays of the sun.

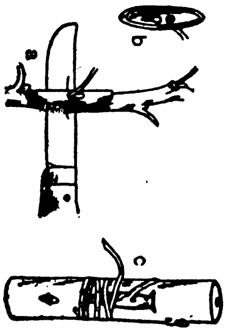
107. Effects of evaporation. The newly transplanted tobacco plant supplies a fair illustration of the behaviour of cuttings that are exposed to the sun. In transplanting, many roots and root hairs are lacerated or destroyed; those remaining intact being out of all proportion to the amount of leaf, and incapable of pumping up enough water to equalize that lost by evaporation. Evaporation carried far enough means death; and the grower, to avert this, shelters the plant with a bit of banana leaf, or plants in the afternoon when the drying force of the sun is spent.

108. Budding and grafting. These operations are modifications of increase by cuttings; the difference being that the cutting is transferred to another plant instead of to the soil. The principle involved is the same. Each process recognizes the bud as a dormant individual, capable under favoring influences of development into perfect plant life. In transferring a bud to another plant, the necessary food and moisture is supplied by the living plant into or upon which it is inserted.

The practice of budding and grafting is chiefly confined to fruit or nut-bearing or ornamental plants, or to those we desire to reproduce exactly alike to the parent.

109. Limitations. Budding and grafting have the same limitations that restrict the hybridization or intermarriage of plants through their flowers. That is to say, that, with few exceptions, bud transferrence can only be effected between closely related plants. A union, as it is called, can be had between a tomato and an eggplant, because they are related; but it is not so enduring nor satisfactory as one between an American and a Filipino variety of eggplant. An excellent union can be made of the lemon upon the orange or vice-versa. They are not so closely related as the two varieties of eggplant, but more nearly than the egg plant and tomato and consequently result in a more complete union.

110. How budding is done. In practice, the art of budding (which has many variations) consists in removing a bud to which is left attached a bit of the bark of the stem from which it was taken; then of opening a slit in the bark of the stem to which it is to be transferred, and inserting it in such a way that the inner surfaces of the two barks be in intimate contact. A tying in place with soft twine, so as to keep the two wounded surfaces closely together, completes the process.*



BUDDING

a. Removing the bud.—b. The bud.—c. Bud inserted in stock and tied in place.

111. Grafting. Grafting consists in transferring a stick (scion) of one or more buds, by means of a cleft, tongue, or other incision made in the stem or branch of stock, as the subject to be grafted is called.

As in budding, the underlying essentials of grafting consist in getting such close contact of the sap-bearing tissue of both stock and scion, as will permit the free diffusion of sap from one to the other. By reason of the larger cut, greater evaporation and danger of decay from the entrance of water, it is customary, in grafting, to complete the operation by covering the wounded parts with wax, clay, or other protecting material.

112. When grafting is employed. Grafting is mostly employed for introducing improved varieties upon wild trees or such as yield only inferior fruits. An old or large stock admits of grafting all of its branches, and in a short time a worthless tree may be converted into one yielding an abundance of delicious fruits.

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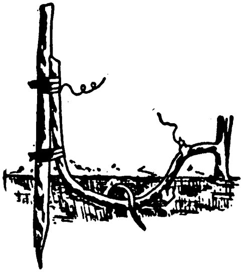
* It is strongly recommended that the student obtain a knowledge of the simpler forms of budding and grafting from watching a practical demonstration made by the instructor.

113. Common use of budding. Budding is mostly a nursery operation designed for the rapid and early increase of desirable varieties. It is generally performed upon small, wild seeding plants close to the root crown. As soon as the bud has fairly started into growth, the whole top of the seedling tree is cut away and its place usurped by the chosen sort.

114. Layering and marcottage. These are modifications of cuttings, resorted to when the increase of very large plants is desired, or to increase those that do not respond to the ordinary treatment of cuttings.

Layering, as the name indicates, consists in laying or bending down to the soil a limb or branch of the plant whose increase is desired. It is bent to the ground, or into a shallow ditch dug to receive it; pegged down, stripped for a distance of its leaves and the stripped portion covered with soil. In a greater or less time, according to the variety of the tree, the buried branch will emit roots, when it may be cut away from the parent tree and planted in another site. The process may be ofttimes hastened by partial ringing (cutting through the bark half way around the stem) or cutting a tongue on the under side before pegging it down to the soil. The effect of this is to form at the wound what is known as a "callus," and from calluses roots are quickly emitted.



SHOWS HOW A BRANCH IS LAYERED

115. Marcottage. When a branch cannot successfully be bent to the ground we layer it by a process called "Marcottage." It consists in ringing or tongueing a branch in the manner described above and then enclosing the wounded part in a basket, pot, or other receptacle filled with light soil. Wrapping with a large ball of moss or other material not subject to rapid decay and the consequent generation of heat, will generally effect the same purpose.

As the success of both marcottage and layering depends on long continued and abundant moisture, the operations are best performed during the rainy season. If undertaken at other times, tireless vigilance to prevent drying out must be exercised. By these means chicos, mangos, oranges, and other fruits requiring many years to come to maturity from seed may be brought to a fruiting condition within two years.

CHAPTER ELEVEN

MANURES

116. Their nature and uses. In talking about soils it was pointed out that there could be no long continued good crop production without a return to the soil of some equivalent for that which is taken away by the plant. It was shown that good soil preparation and careful tillage would do much, more perhaps than any other agents, to promote a good plant growth or, what is usually the same thing, a good crop. Nevertheless, something more is needed if we are to develop to the utmost the young plant whose career we have followed from the seed stage to the present time. This "something more" is manure, and its intelligent and discriminating use is a matter of vital importance to the farmer in the tropics.

117. Natural fertility enhanced by manures. There are soils that are almost sterile and unproductive, and others of almost incredible fertility, but, fortunately for mankind, the greatest extent of lands in the tropics are of average or medium productiveness. These average lands, when properly administered are continuing mines of wealth. In every case they contain the essential mineral elements of plant nutrition in sufficient quantities to maintain crop production for generations. Yet it not infrequently happens that soil conditions are such that much of its fertility is latent, i. e., unavailable for immediate plant use. On this account good lands are condemned that require no more than a judicious use of manure to make them highly productive. On the other hand, the richest lands, seemingly like bottomless mines, often "go poor." They become exhausted for want of special manures whose timely application would have maintained them for all time in a big state of productiveness.

118. Chemistry of manures. In the use of manures a knowledge of chemistry is of much practical value, in so far as it helps the farmer to know how to mix them, and what benefits he may expect to derive from their use. The ability to make a chemical analysis of his soils is not of so much importance; neither is too much stress to be laid on the specific value of soil analysis.

Examinations show that the greater part of our lands have in generous supply the mineral or inorganic elements of foods most in demand by plants. The trouble is that much of this is not in form to be immediately used, and a mere analysis may show a rich character, and yet the immediate crop results may be poor. To correct this the farmer adds manures that furnish material available for plant food, knowing that in time the influences of air and water will unlock those still dormant riches lying in the soil.

It is in knowing how to utilize manures economically that some elementary chemical knowledge will help him. From its study he will learn that, if he piles up a heap of stable droppings where it is exposed to the rain, when wet through it will heat and decay.

This decay, as we found out before, is a process of burning up, and, in the burning, nitrogen is set free in a form called ammonia. Now, ammonia is a very pungent and quickly escaping gas, that is also freely washed out in water. Manure so exposed, consequently, loses most of the ammonia which contains the nitrogen, the thing of all others that we perhaps need and, generally, the most precious ingredient in the manure. Comprehending this, the farmer, who makes practical use of his knowledge, either collects stable manure in pits, heaps it up under sheds, or else gathers and spreads it on the fields as fast as collected. There, if exposed to rain, the nitrogen is washed out into the land where wanted.

119. Commercial fertilizers. Chemical science has prepared a good many useful manurial compounds that are commonly known as commercial fertilizers. The chief end of these fertilizers is to supply in compact and available form the three elements—nitrogen, phosphorus, and potash—that plants most heavily draw upon for their support.

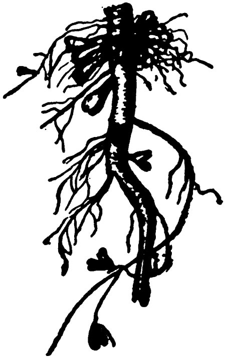
A fourth very great essential, lime, abounds in most soils; but, if wanting, it is generally supplied independently of the others. The value of these commercial manures will be considered more in detail in connection with their uses on the special crops with which later we will have to do; but, now, we will only take up those things that the poorest farmer may command and which the most unlearned should know.

120. Green manures. Green manuring is one, and its name furnishes a clue to its meaning. It consists in growing some crop of quick maturity and, while still green, of plowing the land and turning the crop back under the soil.

Here in the Philippines, more than elsewhere, is there the most need of green manuring, and nowhere is it less practiced. Year after year we raise crops of rice or corn from the same land. From much of the corn land we cut the fodder and bodily carry away *all* the stalks. From rice or from corn that has ripened in the field we cut the grains, and the remaining stalks or stubble are knocked down, raked or piled together and burned, before plowing again. All the fibrous matter in the stalk is thereby destroyed. This fibrous matter, when plowed under the soil, prior to its complete decay, turns to what is known as humus. Practice and experience have shown humus to be immensely beneficial to plants. Its mechanical effect upon the land is such as to effect its easy breaking up into fine, light particles easily permeated by roots, air, and water.

121. Manuring in nature. Nature, in the field and forest, if undisturbed by man, keeps adding an endless supply of humus to the soil, to replace that consumed by decay and the living plants. It is our bad custom, however, to strip year after year every vestige of humus-making material from the ground, and with this practice comes the rapid deterioration of our soil. A green crop plowed under after taking two or three crops of rice from the land would here, as in India, result in a next crop so much better as to repay the farmer for the time it was idle.

122. Wonders of nitrogen. But the green manure crop may be applied in a way to bring other benefits than humus alone. By growing for this purpose plants of the pea family, we can add a new and valuable supply of nitrogen to the soil. These plants, of which cagius, kibal, sitao, and mani are well known examples, have a property, shared in, so far as known, by no other family, of stealing nitrogen from the abundant supplies in the air about us. It is more like a fairy tale than a sober scientific fact to realize that the little white tubercles that clothe the roots of these plants are what we may call, paradoxical as it seems, a beneficial disease, and that the myriad microscopic creatures that inhabit them have withdrawn from the air and stored up in the roots the nitrogen required by the plant. From this knowledge the farmer learns:


ROOT TUBERCLES OF LEGUMINOUS PLANT.

1. That, in growing crops of these peas, pulses, or legumens, as they are variously known, he may be spared the expense of manuring his land with so costly a material as nitrogen.

2. That, if he desires to grow a crop that makes a demand for much nitrogen, and his facilities are bad for buying or procuring it in another form, he has an effective substitute at hand by planting and plowing under a green pulse crop.

He may, if his resources do not admit of his land lying idle the whole season, raise this pulse crop of beans, mungos, kibal, or whatever it be, harvest the grain, and then plow under, but never burn, the stubble. It is true that the manurial gain will not be so great as if it were plowed under green. Much nitrogen will be carried away with the grain that is harvested, and, if he has planted mani, and followed a still worse practice and stripped the field clean—carried away both the nuts and the forage—his renovation crop, as these renewers of soil fertility are sometimes called, will not leave his land or his pocket much to the good.

123. Compost heaps. Another source of manure open to every prudent farmer is what we call the compost heap. A little way from the house, under a nipa shelter protected from the rain, every bit of household refuse should be thrown. Under the same shelter should be piled up in the dry season a generous pile of dust-dry soil. Whenever refuse is put on the heap a few shovels full of dust should be thrown over it. Then, regardless of how foul or offensive the material, the compost heap will give no offense and be no menace to health. All effete or waste material, from house, stable or pen, should be carefully removed from the premises; and wood ashes, rags and dead animals as well be included.

124. Value of Bones. Large bones of dead animals are the only exceptions. These, if possible, should be dried and ground; but, if the farmer lacks a suitable mill, they should at least be broken up before being consigned to the compost heap.

Bones are the source of a large and invaluable supply of phosphorus, and this, after nitrogen, is the most costly plant food material required. Bone, however, decays very slowly and, even when finally broken, must undergo chemical changes before being useful in plant nutrition. These processes sometimes require years. When the compost heap has become of large size, a second may be started, and the first be thereafter carted to the field.

Too much space or attention cannot be given to the important part that the compost heap should play upon every Filipino farm. Bad roads, poor facilities for transportation, and the great first cost of commercial fertilizers place their use and the benefits to be derived therefrom beyond the reach of many farmers; but the green manure and the compost heap are within the reach of one and all. Admirable as are the commercial manures the testimony of all countries and of all farmers goes to prove that, supplemented with farm composted manures, they become far more efficacious, and an easy command of the former should not prevent the farmer from making careful provision for the latter. It will teach him, too, the lesson of thrift; that, as nothing goes to waste in Nature, he, Nature's greatest handiwork, should pattern after her, and see that none of his products go to waste.

125. Rotation. Rotation is a system of planting whereby a crop when harvested is followed by another of very different nature. In a broad sense crop rotation is a form of crop manuring, for we plan that the succeeding crop shall draw plant food from the soil in different proportions than the crop which preceded it. Tobacco, for example, makes heavy drafts upon the potash contents of the soil, while the demands of corn are relatively small. Both make nearly equal calls upon the nitrogen supply. We are able to plant in connection with corn some crops that will restore some of the nitrogen withdrawn by both the tobacco and the corn, and these crops we cannot grow in connection with tobacco. Now it follows that if we plant tobacco for two successive years upon the same land, we have withdrawn far more potash and nitrogen than if we had followed the tobacco with corn.

Moreover, nearly all farm plants get their food material from different depths, and a change of crop allows a rest to the stratum of soil from which the nutriment of the last preceding crop was chiefly drawn. During this period of rest, mechanical and chemical changes are going on in the soil, constructing new sources of food supply, so that when we return to the first crop the conditions for its growth have greatly improved.

An interesting object lesson in the value of crop rotation is sometimes seen in the planting of upland rice on shallow soils. The first crop is often enormous, yet after two or three crops are taken they become so inferior that the palay planter moves away to new land. After a few years he returns and raises as good a crop as the first time. Meantime a natural rotation has been going on. Different weeds and jungle plants have sprung up that have made different demands upon the soil. This has enabled the materials required by the rice to accumulate in the correct proportions and in such quantity as to enable the planter to secure another good crop without having recourse to manuring the land.

CHAPTER TWELVE

IRRIGATION

126. Definition. Irrigation is the application of water to the soil by any other means than rainfall. In our tropics, marked by a distinct dry season, the act of irrigation is often of pronounced benefit to the farmer employing it.

There are crops, some varieties of rice and the Chinese caltrops and gabi, that call for irrigation that amounts to inundation. With these exceptions, when irrigation is mentioned, it means the application of water in moderate quantities.

127. Forms of irrigation. Irrigation is effected:

1. By shallow flooding of the whole surface.
2. By conducting water through ditches or furrows, and looking to its distribution by seepage through the intermediate spaces.

The first method is best employed upon lands that are nearly level. When a field has any considerable pitch or fall, it is evident that water can not be accumulated upon the higher portions, without first throwing up a dyke or retaining wall across the lower part. This results in flooding—the ideal for a rice crop—but not what is desired for most products.

Lands that can be inundated by irrigation are useful for other cultivations than rice, provided the water is promptly withdrawn by tapping the dykes and working the land as soon as dry enough. A single inundation, if followed by plowing and tilling at the proper time, is often sufficient to bring a dry season crop of corn, kibal, or mungos to perfection.

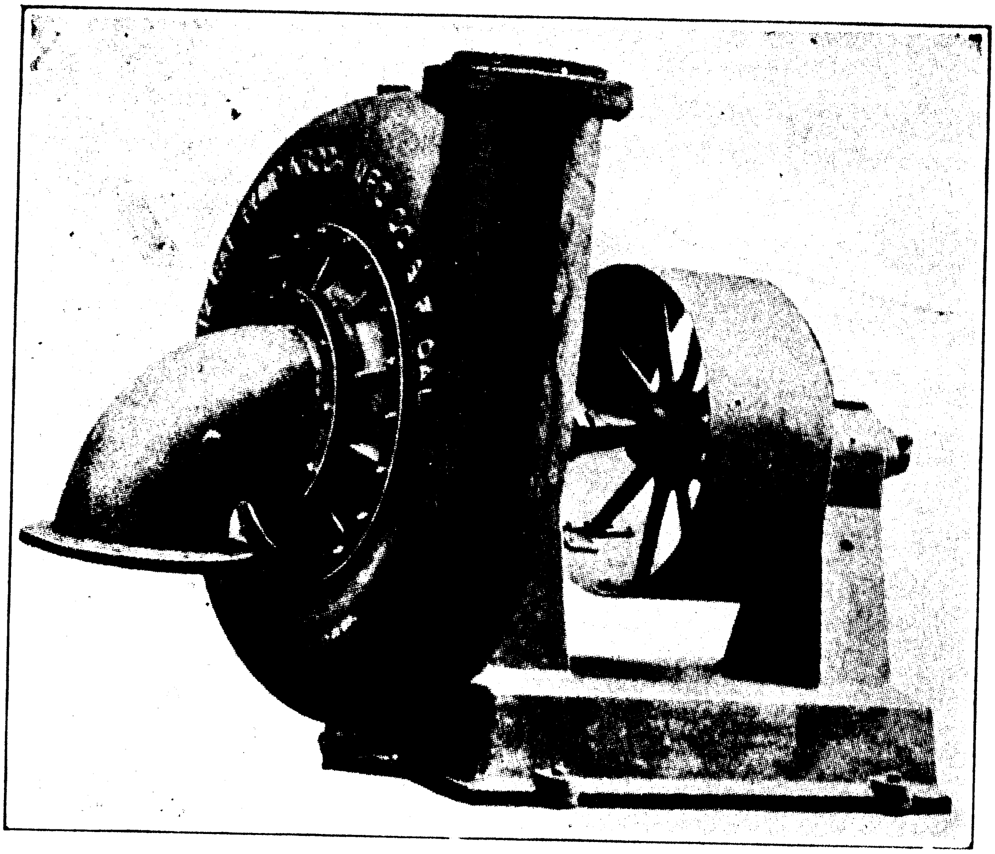
The farm lands of most general utility are those controlled by irrigating waters. We speak of control as meaning lands upon which water can be brought by its own force—by gravitation. It is, therefore, evident that, unless we are to apply water by pumping or other mechanical devices, the source of supply must be a higher plane than the land to be irrigated.

128. To take water from a stream. In taking water from a river, stream or spring, a level is run and ditch dug to the nearest point of the stream, that will carry the water to the highest point to be irrigated. When the stream is tapped, a partial, or wing dam, as it is called, is built. This is carried far enough into the stream to deflect the desired quantity of water into the ditch. The utility of an irrigating ditch depends much on a steady, uniform delivery of water. This is best assured in one dug along an easy grade; that is, one with the least possible fall to transmit the water to the desired point. The same principle should govern the subsequent distribution of water over the land to be irrigated, whether by flooding or in open ditches. By so doing a rush of water may be avoided. A rush, or swift current, generally results in guttering the soil, in insufficient wetting of the higher parts and undue saturation of the lower levels. For reasons stated in the chapter on soil preparation, irrigation is best controlled upon land that has previously been graded to a uniform plane.

128. Necessity for cultivation with irrigation. Irrigation by flooding is useful as a preparatory step for crops that are to be planted during the dry season; also for grains and grasses that quickly grow and completely *shade* the soil. For all hoed crops, such as corn, cane, cotton, or tobacco, furrow irrigation is best. If flooding is employed, unless on very sandy soils, cultivation must follow irrigation if the greatest benefits are to result from its use.

In the rainy season there is an excess of humidity in the air, the sun is greatly obscured by clouds, evaporation is slow and no injury results to rain-soaked soils that lie uncultivated. During the dry season the opposite conditions exist, and unless the ground is densely shaded by growing crops, mischief follows if irrigation but no cultivation is given. Evaporation is rapid and the soil becomes a sun-baked mass whose last state is usually far worse than it was before water was used.

129. Irrigation by furrow. Irrigation by trench or furrow, as the name indicates, consists in opening with a plow, usually a shovel plow, shallow furrows, through which the water is allowed to percolate the length of the field. The process is more economical than flooding, and has the advantage of delivering the water exactly where wanted. In orchard irrigation, it is the common practice to check the water in the furrow and permit it to overflow in the vicinity of a single tree. The check or obstruction is then removed and the water allowed to flow down the furrow till the next tree is reached.



A CENTRIFUGAL IRRIGATING PUMP

130. Centrifugal pumps. Many farms lie along river valleys when the fall of the water is so slight that the current is hardly perceptible. In order to divert water from them upon land only five or six meters above the river level, it would be necessary to dig long and costly ditches. In this case, centrifugal pumps, of moderate cost and calling for but little power, will supply an immense volume of water for irrigating. For greater lifts, double acting pumps, pumps that both force and lift the water, must be employed.

131. Pruning—Definition. Pruning is a garden and orchard operation intended to increase fruitfulness, to promote general vigor, and to act as an auxiliary remedy in disease.

In effecting an increase of fruitfulness the principle involved is in checking the sap and in diverting it from leaf to flower making. For this purpose the knife is seldom employed. Crushing or "pinching," as it is called, the tip of young growing points between the thumb and forefinger will generally accomplish the desired purpose. This will be followed by the appearance of new shoots or branches below the point that was pinched back. It was shown elsewhere that ample sunlight is essential to good leaf growth, which, in turn, is equally necessary to make good fruit. It follows, therefore, that any of the new growths that hinder these conditions must also be pruned away. This operation as well is best performed by merely rubbing from the branch the excess of buds as they appear.

132. Experiments in pruning. As a practical conception of pruning and its results is best obtained by practice rather than by precept, the student should plant repeatedly seeds of such rapidly maturing plants as cucumbers, melons, squashes, tomatoes, and seguidillas. Check plants, i. e., some that are kept unpruned, should be grown for purposes of comparison in adjoining plats, and health and crop conditions of the pruned and unpruned plants carefully noted. Judgment in pruning is indispensable, and is best acquired by the practice indicated above.

133. Pruning for unfruitfulness. Unfruitfulness is often due to crowded branches and consequent insufficient light and air. This calls for the removal of larger growths with saw or shears. In a well cared for orchard occasion for the use of these tools seldom arises. If, however, from neglect or diseases it becomes necessary to remove a large limb or branch, the cut should be clean and close to the stem or branch from which it is taken. The cut should also be made with such a slope that the wound will not hold water. The strict observance of this last rule is especially called for in the tropics where moisture, in connection with great heat, speedily sets up decay. When this happens the plant is in a strongly receptive condition for those micro-organic diseases described in another place.

134. Water sprouts. Some fruit trees, notably the orange, cacao, and ates, throw up watery suckers from the root. If these are allowed to grow, they attract a large share of nutriment from the root at the expense of the fruit-bearing power of the plant. Their removal, with one exception, is always in order. The exception is that if the main body of the plant is diseased, we can cut it down and renovate the tree with the vigorous sucker.

135. Pruning as a remedy for disease. Pruning is an admirable remedy for certain diseases that originate within the tissues of plants. Judicious and energetic use of the knife will sometimes stamp them out. The prunings of diseased plants should always be burned to prevent further spread of the disease.

CHAPTER THIRTEEN

PLANT DISEASES AND INSECT ENEMIES

136. Definition. For the farmer's purpose, any departure from the normal, that is, crop loss resulting from any causes other than violent physical disturbances, such as fire, flood, or typhoon, is to be considered as due to disease. Strictly speaking, the crop's injury incident to prolonged drouth or to excess of moisture comes under this head, but they carry their own suggestion of the remedy, and we irrigate, cultivate, or drain as the requirements of the case demand. Other diseases of less obvious origin, and often with protracted and varying life history, call, however, for extended study and explanation.

137. Classification. For convenience, and not on account of 'sharply defined differences, we may classify all plant ailments other than those named above as follows:

1. Diseases caused by micro-organisms.
2. Diseases due to insect or animal enemies.

138. Micro-organisms. Micro-organisms are forms of animal or vegetable life, frequently so infinitely small, that thousands of their bodies are contained within the space of a cubic millimeter. They belong to the lowest grades of life, and, in common with such types, have the objectionable habit of rapid development from the seed to the adult stage. Still worse, they are early endowed with the power of reproduction and in quantities inconceivably great. This reproduction or increase is effected by means of dust-like bodies known as spores. These spores are widely distributed by the winds, rains, animals, and, unconsciously, by man. Wherever they find lodgment upon a suitable host, that is, upon a plant whose tissues will supply them with the proper food, they rapidly grow at the expense of the plant that harbors them. When fully grown, they reproduce and scatter anew their pestiferous spores by thousands.

Diseases that fall within this classification are many, and are commonly called rusts, smuts, blights, spots, wilts, moulds, mildews, and cankers. Owing to the microscopic size of the spores and their incredible rapidity of increase, the control of such diseases is one of the gravest problems that confronts the farmer.

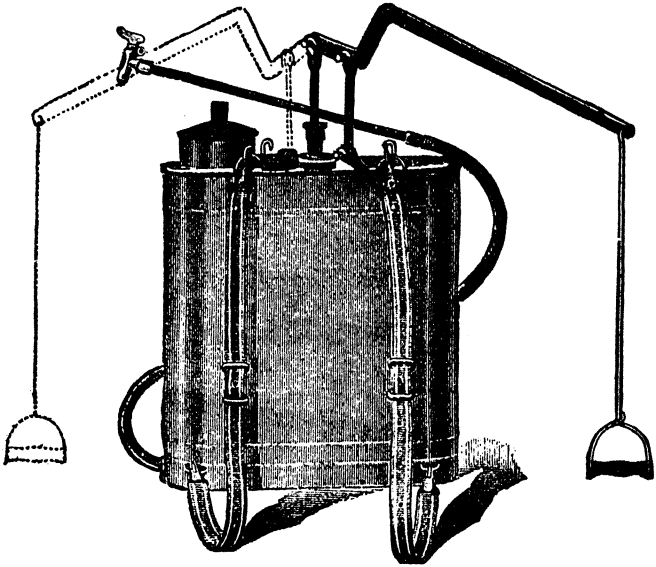
For further convenience, spore diseases may be roughly separated into two groups.

1. Those whose ravages are mostly confined to the inner structure of plants.
2. Those whose attacks are made upon the outer or external tissues.

139. Smuts, etc. The first of these, represented by the smuts of rice and other grains, by the leaf spot of coffee and the canker of cacao, are among the most difficult to control. As was previously pointed out, in the case of rice (and it occurs with other grains), the spores of the disease find lodgment on the seeds. When the latter is softened in the course of swelling and sprouting, its tender structure is easily pierced by the spore. This in turn grows, and is carried along in the juices of the growing grain until the latter is perfecting its seed. At this stage, when rich with starch and gluten, the seed is attacked and consumed by the invading disease. As the crowning act of its career (for its own life ends with the exhaustion of the host plant), it issues countless spores in readiness for a repetition of the story another year. Until the last moment, it has lived in entire harmony with its host, nor has it given the slightest evidence of its presence to the closest observer.

It is obvious that no remedy can be applied to arrest a disease that does not disclose its progress by anything until it has run its disastrous course. To meet such a situation, we have recourse to preventive rather than curative means, and attack the disease in its incipient or spore stage. This is effected by treating the grain seeds with baths of corrosive poisons, dilute enough not to injure the tough, protecting cover of the seed, yet strong enough to penetrate and destroy the tender structure of the spore. The destruction of the spores that adhere to the grain is a practical guaranty of success. Though the ground be covered with myriad spores, immediate contact with the seed at the moment of the latter's germination, appears to be the only time when the disease can obtain a successful foothold.

140. Spore diseases of coffee and cacao. Still greater vigilance is called for in the treatment of such diseases as the leaf spot of coffee or the canker of cacao. In the former, the spore finds entrance through the tiny stomata into the leaf; in the latter, through the smallest bruise or injury to the woody tissue. Once lodged within the tissues of the plant attacked, they spread rapidly, and run riot through leaf and wood till the whole internal structure is destroyed and the plant dies. Here, no internal remedy can be applied that would not be equally destructive to the host plant. In these cases we also resort to preventives and spray the threatened plant with mixtures known as fungicides.* When these diseases are once established the action of fungicides is negative. Their application is only useful while the plant is still in perfect health, and as a means of warding off expected infection.



A GOOD KNAPSACK SPRAYING PUMP

Spraying with a force pump is the means whereby we distribute dry powder or liquid remedies in the form of a fine, mist-like spray to all parts of a plant. The value of spraying depends upon its frequent repetition and, above all things, with the absolute and painstaking thoroughness with which it is done. The complete exposure to the liquid of every particle of the plant's surface is the essential to success. Unless this is done, the operation generally results in the loss of time and material.

141. Mildews, etc. We have now briefly to consider the second subdivision of spore-born maladies, whose attacks are made upon the external structure of plants. These are the mildews of kibal and patani, and the so-called black smuts of cacao, mango, orange, ate, and other fruits belonging to this group. For these diseases, the application of a fungicide spray is a positive specific.

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* The preparation and methods of using standard fungicides will be found in the appendix to this volume.

Its action is to destroy, not only the spores, but the exposed, living organisms as well. Its application, if timely and thorough, will effectively arrest the progress of the disease.

There are still other and more obscure phases of micro-organic disease, that by reason of their likeness to the maladies that attack men and animals, are called bacterial. In these diseases, the entire life history of the malady is confined within the inner structure of the plant attacked. Wilts and blights belong to this group and, as yet, no specific remedy for their control is known. Cotton, melons, and tomatoes are the only tropical cultivations that, so far as known, are subject to their attacks. The breeding and planting of resistant varieties is the only method yet devised for successfully coping with these troubles.

142. Resistant varieties. Resistancy in a plant means a tendency to immunity, not positive immunity from disease. It is a product of the careful selection and breeding of plants that have escaped attack, or successfully resisted attack, in disease-infected areas. Wilt-resistant varieties of cotton and leaf-spot-resistant sorts of coffee are illustrations of what has already been effected along this line of effort. In general, resistant varieties are characterized by great vigor of leaf, stem, and root. Advantage has been taken of this to use them as stocks upon which to graft weaker, less resistant varieties of exceptional value otherwise.

143. Cultural remedies. There still remains for consideration, one other preventive measure against *all* plant disease that, in importance and utility, transcends all the "cure alls" known. It consists briefly, in intelligent work; in maintaining such high pressure tilth as will keep the plant at all times at the highest possible tension of normal growth. Like resistancy in varieties, this treatment gives no positive assurance of immunity, but abundant experience has demonstrated that good cultural treatment alone, or in connection with the planting of resistant varieties, is the best *general* antagonist to plant disease yet devised.

144. Insect enemies. In describing insect pests, it is once more convenient, for the farmer's purposes, to subdivide them.

1. Insects that destroy the plant tissue.
2. Those that prey upon plant juices only.

145. Chewing insects. The first class is represented by insects, or their larvae that bite, tear, or eat any and all parts of the plant structure. Such are the weevils that perforate rice, corn, beans, and other seeds; the slugs, worms or caterpillars which feed upon the tender foliage; the flies, moths, and beetles which eat of, or whose larvae eat of, leaf, flower or fruit, or which burrow into the hardest woods. Spraying with diluted mineral poisons is the best way of keeping these pests in check, and the use of arsenic in some of its forms has been found to be the most satisfactory spraying agent.*

There are stages in insect life when they are either inactive or not engaged in feeding. Application of poisons at these times is unavailing; therefore, a study of the enemy's life history is an indispensable equipment for the farmer who is to wage them successful warfare. He will thereby learn the stage when they are the most susceptible, and carry on the fight with the least expense and the best results.

146. Use of arsenical compounds. Arsenical compounds should be used with care and discretion, remembering that, in large doses, arsenic is as destructive to plant as to animal life. Its proper use is attended with no danger to human life. It should not be applied, except in the very earliest stages, to garden greens like cabbage, lettuce, and celery, that are eaten raw or that are apt to fall into the hands of an unclean cook.

The use of insecticides should be marked by the same thoroughness that fungicides require. All parts of the plant should be exposed to the liquid or powder, in order that the insect may eat no portion that is not a poisoned bait.

147. Use of poisonous gases. The application of poisonous washes to stored food grains would be attended with danger, hence, when infested with insects, they are placed in closely sealed bins and exposed to poisonous vapors. For this purpose, a highly volatile liquid like carbon-bisulphide is used. The gas is fatal to life but after treatment, if the seed is exposed to the air, the gas is dispelled and the grain uninjured.

By means of tents or temporary housing, plants growing in the open are sometimes exposed to the fumes of exceedingly poisonous gases. This treatment is expensive, and only used upon insects that stubbornly resist the influence of sprays.

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*Formulae for the preparation and application of arsenical sprays are contained in the appendix.

148. The locust. It has been the purpose in this book to disregard any details that did not serve to illustrate some general law or practice. An exception is made here in the case of one leaf-eating insect, the locust. This, our national insect plague, has so far resisted all the methods in common use for the suppression of insect pests. On account of its far-reaching influence upon Filipino agriculture, the subject calls for detailed consideration.

149. Fighting with poisons. The locust has the faculty of incubating, in some years, two or more broods of young. This, in connection with its size, voracious appetite, and appearance over large areas in countless millions, makes its suppression a matter of exceptional difficulty. The use of poisons on a scale large enough to cope with an evil of such magnitude is impracticable. Furthermore, a drug so deadly to most insects as arsenic, is consumed by locusts in appreciable quantities without injury. Inoculation with parasite disease, while in theory the ideal remedy, has, in practice, so far, failed to give good results. Sensitive to noise, the expedient of making a great din has no more effect than to drive them from one feeding place to another.

150. Driving into ditches. Of all the methods so far tried that of driving them, while in the early hopper stage, into traps or ditches has proved the most effective. At this stage, before they can fly, they are easily driven in any desired direction. By concerted action, a close cordon of workers, carefully beating the grass and bushes, can clear a very large district of the scourge. The drive should be towards a deep, natural ravine or prepared ditch, with guards posted on the far side to prevent the insects from crawling out. By this plan, tons of them are sometimes entrapped and killed in the ditch.

In addition to driving there are two practical remedies, both of which are simple, and, if followed, will greatly reduce crop losses from this cause.

One consists in planting farm boundary lines to the common spiny bamboo. Occasional disturbance of the locusts in rice, cane, or other cultivated fields, will cause them to settle and feed upon the bamboo. This provision of a food supply for the pest will afford some exemption of the cultivated crops. The bamboo is easily grown, almost indestructible, and, though stripped of all its foliage, will renew itself against the attacks of another season.

151. Crop diversity as a remedy. The second remedy is within the control of every planter, and consists in growing a diversity of crops. This, practised in connection with bamboo planting, affords a positive guaranty against serious loss, and, in the present state of our knowledge, is the most rational method yet devised for the control of the plague.

The locust, by preference, attacks only what are known as the cultivated grasses. Under this head are included such grains as corn, palay, and batad; also sugar cane, sorghum, and teosinte. When denied these, they turn their attention to bamboo and the wild grasses of the fields. When the choicest of these are exhausted, they attack the foliage of cocoanut, buri, and other palms. There are, however, entire families of cultivated plants that are positively immune and others that are certainly distasteful, if not wholly exempt. These last they avoid until every vestige of the wild grasses of the district are consumed.

It is in growing these locust-resistant crops that affords the most protection to the farmer at the present time. The exclusion of all grasses is neither practical nor to be recommended. In practice it would wipe out rice, corn, and sugar, our three most important food products. The recommendation is made, however, to supplement those cultures with locust-resistant crops. Any food deficiency arising would be met by the sparing introduction of the food grasses into districts now dedicated to other cultivations.

152. Crops that are immune. Among plants known to be immune are all members of the nightshade family. In this are included tobacco, potatoes, tomatoes, and egg plants. These are all crops that offer inducements for more extended planting. The sticky foliage of Sesamum (*linga*) is exempt, and, so far as known, the whole vast family of legumes. They at least are known to be most obnoxious to the insect. It is possible that their seeming immunity is not absolute, but dependent on the exhaustion of bamboo and other wild grasses. As the legume family includes indigo (*anil*), peanuts (*mani*), cowpeas (*kibal*), pigeon peas (*cagius*), lentils (*mungo*), running beans (*utao* and *patani*) and a host of minor economic products, it is seen that the planter enjoys a wide range of selection. It is also apparent how marked a restraining influence upon the locust plague a diversified system of crop planting can bring about.

153. Crops for experiment. Attention is also directed to the behaviour under locust invasion of native yams, camotes, ubi, mangos, bananas, abacá, and maguey. This, not so much for asserting their immunity, as to encourage among students habits of close observation. The exercise of this faculty will enable them to determine upon cultivations, by means of which, they may hope to wage successful warfare against the most dreaded enemy known to Filipino agriculture.

154. Sucking insects. The next group of insects we have to consider are true parasites which derive their nourishment by sucking the sap or watery juices of the plant. They are provided with the means of making a minute puncture in leaf, twig, or fruit, and have, as well, a delicate pumping apparatus for withdrawing the sap.

Plant lice *(aphides)* belong to this class, are both winged and wingless and are usually found thickly clustered about the tender, succulent points of the plants they infest. They multiply with astonishing rapidity, and are such persistent feeders that they quickly sap the vitality of the plant.

Other serious plant pests that derive their sustenance from plant juices in much the same manner as do the aphides are called scales. Scales belong to a large family, all of which, and without exception, are injurious to vegetation. They are generally flat and lie closely appressed upon the smoother bark of limbs and the under surface of leaves. In form, scales are round, oblong, thick or thin. Some are smooth, others wool-covered or fluted, tender, or protected with horny plates. Their diversity of color is nearly as great.

155. Methods of fighting. As these insects do not eat any of the outer structure of plants, it is obvious that we cannot apply poisons to their food. Hence, we have recourse to mechanical means, to killing them by contact. For this spraying mixtures are used that penetrate their tissues, or that coat them with an air-tight film and kill them by suffocation.

The very thin-skinned lice and the most tender species of scales succumb to spraying with the milder vegetable poisons, tobacco, hellebore, etc. Those of harder texture are reached by the caustic alkalies alone, or in combination with resins, or emulsion of the mineral oils.*

Pruning away diseased parts is a specific in some plant maladies. Pruning, however, having a wider influence upon plant life than in the control of disease, has been considered elsewhere as a separate topic.

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*Kerosene, or refined petroleum, is now conceded as the most effective, *general* insecticide for the extermination of sucking insects. The most approved method of using it will be found in the appendix.

PART III

SPECIAL CULTIVATIONS

CHAPTER FOURTEEN

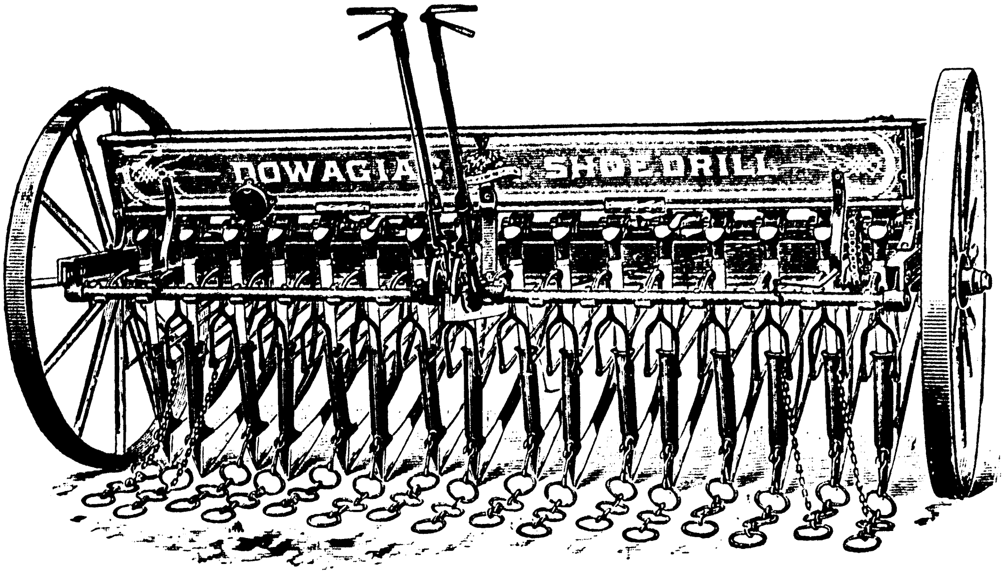
RICE

156. Upland vs. lowland rice. Rice, or palay, as the unhusked seed is called, is the product of two varieties of an aquatic grain, one of which, through long processes of selection, has become accommodated to limited moisture requirements. This is known as upland rice, and that which requires flooding in cultivation is called lowland rice. Upland rice is generally less productive than lowland rice. This is not so much due to inherent inferiority as to the defective cultivation it so commonly receives. Upland rice still retains enough traces of its aquatic origin to call for more moisture than is required by most of the cereal grains. To meet this requirement we plan to sow early in the season so as to get the benefits of the entire rain-monsoon.

157. Soil preparation for upland rice. Soil preparation is of the simplest. A single plowing of 10 to 12 cm. is generally sufficient on soil not too impoverished by long cropping to the same grain. Of course it is to be understood that the single plowing is made with a modern plow, or with one that completely inverts the furrow slice and buries all young weed growth. If the ground turns up in clods it should be broken down with a disc harrow or a clod crusher. At this season of the year weeds spring with surprising rapidity, and the land should be kept constantly harrowed and be entirely free of weeds at the time of planting.

158. Planting with a drill. Planting by means of a drill, horse or hand machine, has many advantages over hand planting. It is not only expeditious and labor saving, but by more equal, regular, and rapid planting, assures a more uniform stand of plants. A uniform stand is a most important factor in rice growing, for it results in more even ripening of the grain at harvest time.

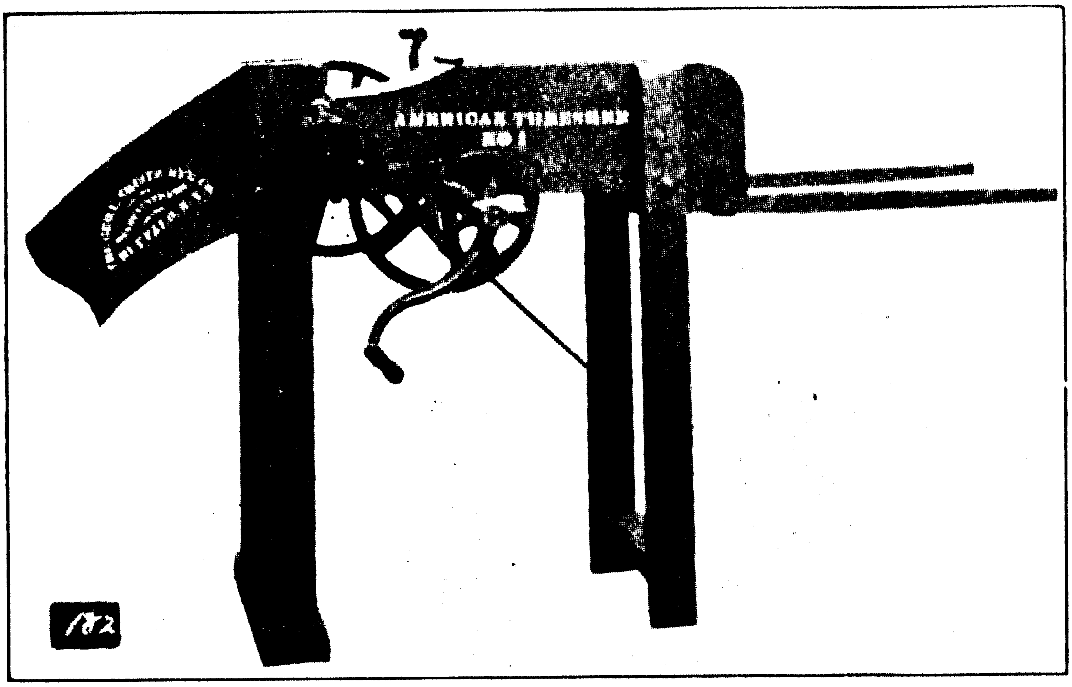
This, in turn, permits the use of the best class of harvest machinery. Rice, particularly upland varieties, shells out its seed freely at maturity, and if allowed to get overripe much is lost. Consequently, a field that ripens irregularly allows of no other than the old and unsatisfactory method of harvesting the crop as it ripens with a sickle.



A MODERN SEED DRILL

159. Proper soil preparation. Rice sown with a drill, being seeded at a sufficient and regular depth, can be smooth harrowed without injury after the grain is several centimeters high. This process will break up any surface crust that may form, effectively conserve the moisture of the soil, and destroy any surface weeds that may sprout after planting the grain. Through faulty soil preparation weeds often take full possession of young rice fields, and the very difficult expedient of weeding a large field by hand becomes necessary. Far better would it be to sacrifice the seed, plow everything under, and sow anew. The tramping of the army of workers who weed the field compacts the land, and, if rains happen to be deferred, the soil will rapidly dry out and the young plants receive a check from which they seldom fully recover.

160. Harvest machinery. Rice, as has been stated, should be harvested promptly at maturity. Most reaping machines, or even the scythe and cradle, which cut and gather the grain in bundles, are great improvements over the sickle, which is in common use. Those machines which cut, gather, and automatically tie the grain into bundles leave nothing to be desired in efficiency and saving of labor. In the lowland rice harvest the use of these machines is only profitable where nearly level lands permit of good sized fields unbroken by dykes. In rolling country, broken by many dykes, the use of the cradle is the most economical. As the upland rice harvest does not occur till the approach of the dry season, the bundles of rice may be gathered into shocks or stacked until convenient to thresh.



A SIMPLE MACHINE FOR THRESHING RICE BY HAND

161. Lowland rice. Lowland rice is grown in both seasons. That which is produced in the rain-monsoon derives the benefit of rainfall merely as an addition to irrigation. A fundamental necessity of its culture is a fine clay soil or one retentive of moisture. With this there must be such careful grading and dyking as will permit the holding on the land of 15 to 20 cm. of water. After withdrawal of the water, shortly before harvest time, the soil of the paddy becomes hard and baked. In this condition, with our usual facilities, it cannot be prepared for another crop without flooding and plowing under water. The farmer who is equipped with sufficient draft animals and modern discing and clod crushing machinery, is able to dispense with so wretched and laborous a process as cultivation while the land is under water. With such an equipment the paddies may be broken up while dry, harrowed down, and, when the surface is sufficiently fine, be sown by drill the same as upland rice. Whatever the method employed the initial preparation of a lowland paddy is far move exacting in labor and animal power than a like area in upland cultivation. On the other hand, after opening the water gates and flooding the paddy, with occasional attention to renewing the lost water of evaporation or seepage, there are no further operations called for till the harvest. The flooding, essential to the rice, is fatal to nearly all weed growth, and the weeding often necessary in the upland cultivation is dispensed with in the flooded fields. The practice in under-water cultivation is to first admit water in a small paddy, plow and harrow it, and then carefully smooth the mud over for a seed bed. Water is then admitted and the seed rice thickly sown thereon. While this is sprouting the main fields are flooded, plowed, and prepared for planting. When the seedling rice plants are 15 to 20 cm. high, they are pulled, the tops slightly cut back, and replanted in the wet, miry paddies where they are to remain. The process is now completed by flooding the newly planted paddy with water.

162. Desirability of rotation. It is our bad custom to take two inferior crops every year from many of our lowland paddies. In tropical regions where better practices prevail it is the custom to take only one excellent crop. There, during the rainy season and without irrigation, it is customary to make a rotation crop of jute or sesamum (*linga*), or a renovation crop of pigeon peas, kibal, or mungos.

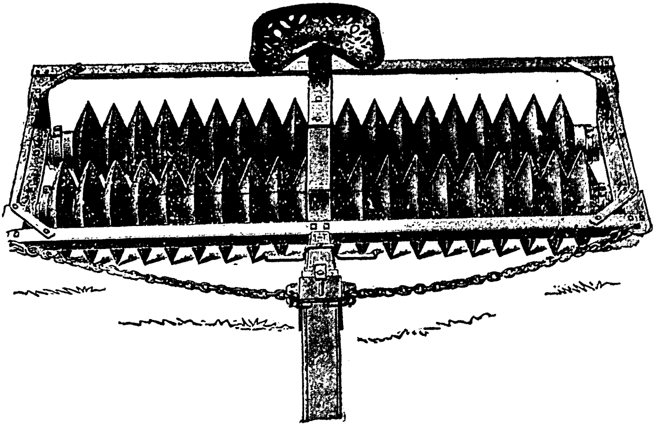
In our soil and manure studies it was shown what an important part the last named crops play as providers of nitrogen and humus and with positively no cost to the farmer. The rice planter who fails to make this provision is burdened with the extra cost and labor of growing two crops. His more enlightened and progressive neighbor, with the help of renovation planting, secures a single rice crop equivalent to the two of the other grower.

163. Fertilizers. The continued, successful, semi-annual cropping of a rice paddy is made possible only by the liberal application of complete manures. It can be accomplished by the annual use of about 350 kilos per hectare of acid phosphates, supplemented with generous quantities of stable or home composted manures. Failing these latter some of the organic nitrogen manures should be employed. Nitrogen in the form of the nitrates should never be applied to lowland rice paddies. Much of it will leach away before it can be appropriated by the plant. Phosphates are economically administered when drilled in along with the seed. Many seed drills are now supplied with what are known as "fertilizer attachments" which distribute the manure where it is most needed. Thus treated a rice paddy may be kept continuously cropped and highly productive for an almost indefinite time.

CHAPTER FIFTEEN

SUGAR CANE

164. Soil requirements and general traits. Sugar cane is a rank growing, gross feeding grass that calls for strong, rich, mellow soils, deep plowing, thorough tillage, and, if exposed to long continued drought, irrigation as well. It may be planted at almost any season, but for convenience of harvest and to secure the largest amount of sweetest juice, we plant so as to reap when those conditions are at the best. As the plant with us takes nearly a year to mature, it is planted in January or February. Thereby the benefit of a long, dry harvest season is secured the following year. The ground at this time is hard and dry, and as harvest and planting proceed simultaneously, it is obvious that, unless there are facilities for irrigation, a new soil preparation of land from which a crop has just been taken cannot be made.



A CLOD CRUSHER FOR HARD, LUMPY LAND. REQUIRES FOUR NATIVE ANIMALS.

165. Ratooning or the alternative. To overcome this it is the practice to sometimes raise a second or ratoon crop from the roots of the old plants. The alternative lies in preparing a new and unoccupied piece of land. For this latter and far more satisfactory method .the land must be plowed before the close of the rainy season. By consequent continued good tillage it is kept moist until the time of planting. Sugar cane is a deep rooting grass and one of the few that calls for deep plowing. Eighteen to twenty cm. is none too much, and more is better if tools and animals will allow. It is still better, if the soil is a retentive clay, that the plow should be followed by a subsoiler and the soil broken up a few centimeters deeper.*

166. Planting. At the time of harvest the cane is cut, stripped of leaves, and the tips carefully protected from drying out, are reserved for seed. If the extreme tips furnish insufficient seed the next adjoining upper part of the cane is used. It is less valuable for sugar making than the lower portion of the stem. Progressive planters select their seed with the utmost care. For this purpose they make analytical tests, reserving for seed, canes that show the greatest percentage of sugar in the juice and the highest purity. Weight of cane and sturdiness to resist breaking down are also useful factors in seed selection. The selected seed cane is planted in an especial bed and is the source whence the planter expects to maintain the high standard of future crops. Prior to planting, according to an excellent Filipino custom,† the seed cane is submerged in water for two days. This swells the buds and encourages sprouting before the seed is attacked and destroyed by ants.

167. Preparation of the bed. The land, with the aid of a middle burster, is then laid out in beds 1.3 to 1.5 meters wide. The middle burster is a ditching plow with a double mold-board that throws a furrow to right and left. In low lying lands, subject to overflow, the dead furrow left by the middle burster should be plowed out again and the dirt thrown upon the adjoining beds. With a shovel plow a furrow is now opened down the center of the bed, deep or shallow as the surface moisture is near or remote. The cane tips, closely touching end for end, are then laid down the length of the furrow. The furrows are then closed, and the beds lightly harrowed with a harrow, the teeth of which are set at such a slant as not to tear out the cane. At this season weeds appear sparingly, and only occasional soil stirrings are required until the young sprouts are well pushed through the soil.

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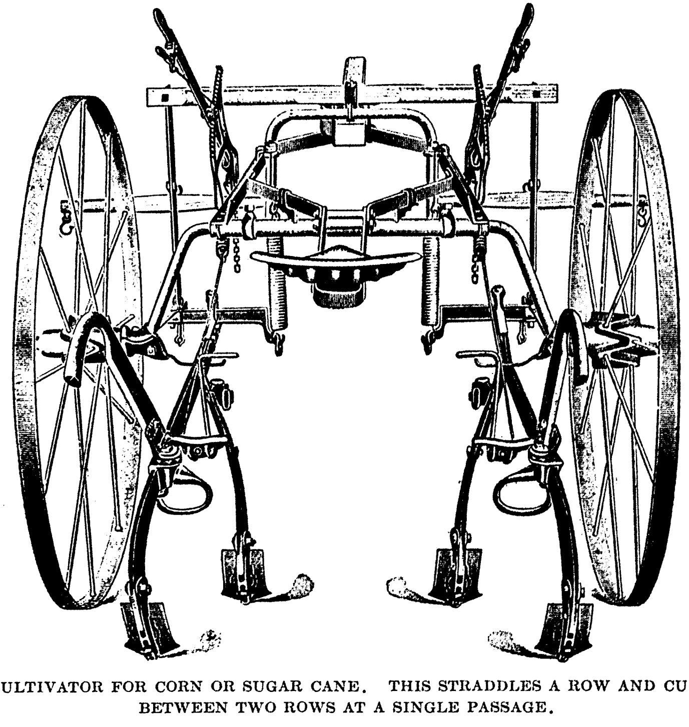
*In the Hawaiian Islands, where the culture of sugar cane reaches a degree of perfection attained nowhere else in the world, the ground is often plowed to the depth of 70 to 75 cm. This is effected by means of powerful steam plows to which heavy subsoilers are attached.

†Sugar cane growing, as practiced in the Philippines, is generally bad and so much at variance with the methods used in other tropics that native processes have been ignored. Exceptions are made in favor of one or two meritorious details of culture.

168. Manuring. At this stage root growth is mostly downward, and plow furrows can be opened quite close to the stems without injury to the root system. These furrows are used for irrigation, or, if irrigation is not called for, as a receptacle for a dressing of manure. For this purpose complete fertilizers, to which a little cotton seed meal has been added, are the best. For this latter substitutes of the press cake of castor seed, copra, sesamum, or lumbang will give satisfactory results.

169. Cultivation. This should be frequent and, during the earliest stages of growth, *away* from the plant. Later, and when the rains are well advanced, cultivation should be *toward* the cane so as to cover the surface roots that at that time begin to develop from the crown. In general, level cultivation is the most satisfactory "Hilling up" is the working of the soil into ridges about



RIDING CULTIVATOR FOR CORN OR SUGAR CANE. THIS STRADDLES A ROW AND CULTIVATES BETWEEN TWO ROWS AT A SINGLE PASSAGE.

the cane rows. The utility of hilling up depends upon rainfall and the sufficiency of the middle furrows to carry off any excess of water. Growth progresses rapidly during the rainy season and such intermittent cultivation as the weather permits should be continued.

With the first indications of ripening, cultivation should come to an abrupt finish. Until this point, the aim of the planter has been to stimulate growth by all the means at his command, and he now strives to retard growth and ripen the perfected canes. This is promoted by entering the cane fields and stripping away the heavy, lower foliage of the plant, and exposing it to the drying influences of sun, wind, and air. This is so assisted by the now approaching dry season that a point of ripeness soon arrives when the cane may be profitably harvested.

At this time a heavy rainfall is a serious and unmixed evil. Sugar cane is a perennial grass and the well ripened stems, that under ordinary circumstances would remain dormant, when influenced by heat and moisture readily break into new growth. When this happens it results in breaking down the stored up sugar contents into other compounds. This seriously impairs the value of the cane for sugar making.

Planting of lands susceptible to irrigation may be deferred till March or April. Under the stimuli of water, manure, and cultivation, the finest crops may be rushed through to maturity by the following January. Irrigation, therefore, in our climate, allows of continuous cropping of the same land to cane. When this is practiced, without intervening rotation or soil renovating crops, it is to be understood that success depends upon the generous use of high grade fertilizers and unexceptionable tillage.

When the cane is ready to harvest it is cut closely to the ground with bolos or cane knives, stripped of leaves and tips, and hauled to the mill.

CHAPTER SIXTEEN

CORN

170. Comparative value. Corn (maize), while not so universally grown as rice, is in many respects the most important of all our tropical farm crops. Its cultivation should be part of the routine of every farm and understood by every farmer. Some of the reasons why the culture of corn should have equal if not greater attention than that now given to rice are mentioned here.

1. Its cultivation is suitable to a greater variety of soils.
2. Its production calls for less outlay for labor.
3. Its harvest matures more rapidly.
4. Its food value for man or animal is nearly equivalent to that of rice.
5. Its yield per hectare is enough more than rice to offset the greater market value of the latter per unit.
6. Since it is a hoed crop the conditions that affect success or failure are more within the farmer's control than with rice or any small grain.

171. Treatment of sod land for corn. While corn growing can be made profitable on a great variety of soils, a rich, sandy loam is the one productive of the biggest crops. Grass land of this nature when newly planted to corn often gives surprising returns. In this case the buried and rotting herbage contributes much to the excellence of the crop. On some grass lands, "cogon" for instance, that are provided with a tough, dense root system, it is difficult to completely invert the grass by plowing. If inversion is not complete, cultivation merely starts the grass anew. Corn should not be planted in such sod lands until a crop of mungos, kibal, or velvet beans has first been taken from it. These plants grow so rapidly that they completely choke out the grass, enrich the soil, and leave it in the best possible condition for corn.

It may be of interest to the student to know that there is a record crop of 237 bushels of shelled corn to an acre of land. This is equivalent to 275 cavanes or 255.4 piculs per hectare. Further, that 75 bushel yields (equivalent to 87 cavanes or 81 piculs per hectare) are not uncommon yields in some countries. In our country, owing to our defective system of cultivation, 15 cavanes per hectare is considered a fair yield, and it is doubtful if there is any maximum much in excess of 30 cavanes.

172. Plowing for corn. On light, loamy soils, shallow plowing (10 cm.) is sufficient. On stiff or heavy soils the plow should be put a little deeper. The use of the subsoiler is uncalled for in corn growing unless as an incident to opening drains, etc. When the land has been plowed and harrowed down to a fine surface it is ready to plant.

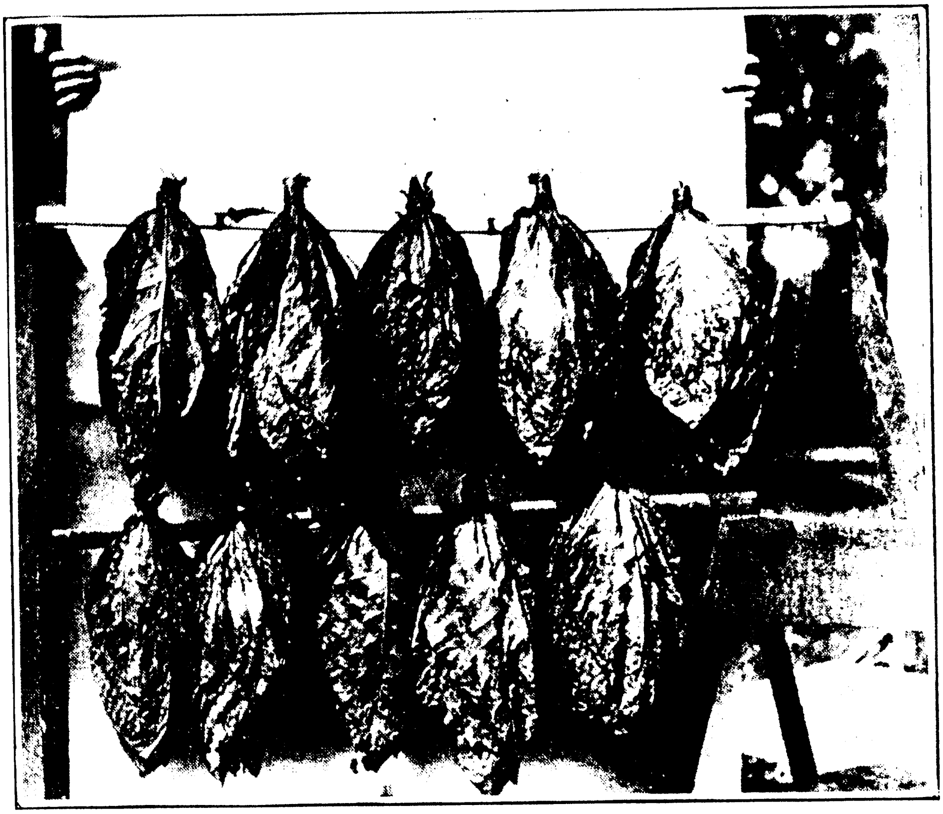
SEVEN VARIETIES OF BANANAS GROWN IN THE PHILIPPINES.

173. Directions for seeding. Seeding can be done by hand by opening a shallow plow furrow and dropping three or four seeds at intervals of 60 to 70 cm. Preferably, however, it should be done with any one of a number of excellent machines regulated to drop three or four seeds exactly where desired. The land is first marked off with a marker into parallel rows of the proper width. They should be a full meter apart Big crops are only produced on big plants and big plants require ample space for their development The planting machine is then driven across the field at right angles to the first lines, planting the seed at the intersecting lines only. This process checks off the field in perfect alignment, permits of cultivating with animals in two directions, and practically does away with any subsequent hand labor.

174. Success due to cultivation. Good cultivation probably contributes more to the success of corn than any other agent. It is *the* key to a good crop, and the importance of check planting as an aid to this end is obvious. An exception is to be noted when corn is planted on hillsides. Here planting should be made in parallel, unchecked lines running around the hill and cultivation given only in the same direction; cultivator furrows *down* the hill, form convenient gutters for rain to wash and denude the soil. When the young corn has sprouted a few centimeters a smoothing harrow should be passed over the field. This will destroy germinating weeds and do no injury to the corn. After every shower, or on the slightest indication of a surface crust, the harrowing should be repeated. When the corn gets a little larger, soil stirring must be done with a cultivator. Cultivation must be shallow, and especially so when the implement is run close to the plant. It is of the utmost importance that the surface feeding roots are not injured. Very convenient implements, known as straddle cultivators, are now in common use. They have an elevated tongue that rides directly over the row. An animal walks on each side and consequently two rows are cultivated at the same time. With such a machine a man and team of good animals can readily go over four or more hectares in a day. No hard and fast rules can be laid down as to the number of cultivations that a corn crop should receive. It is enough to say that they should be frequent, and the more dry the weather, the more frequent the soil stirrings.

175. Rotation with other crops. It is quite impossible that the crops recorded in a previous foot note should ever be secured unless good cultivation is supplemented with both manure and crop rotation. Corn may be grown at any time, and, when planted in the dry season, a good succeeding rotation is upland rice. When produced in the wet season it may be followed by cotton or linga which are dry season products. Stress is laid on the value of these last rotations on account of the utility of the by-products to the farmer. The seed of the cotton and the press cake of the linga furnish nitrogen in the so much desired organic form.

Much of the manure required to perfect a good corn crop may be applied indirectly through the previous preparation made for a cotton crop. If the crop that preceded the cotton was corn, and was properly handled, it was grown in connection with a "catch crop" of kibal or velvet beans. A catch crop, and how it is grown along with corn, is fully considered under the heading "Forage Crops." For the cotton the land is now manured with acid phosphate at the rate of 250 kilos, and muriate of potash, or its equivalent, at the rate of 60 kilos per hectare. When the cotton is harvested, one hundred loads of yard manure, or 1,500 kilos of cotton seed per hectare, are spread upon the land and plowed under. This, and good subsequent cultivation, should result in a maximum corn crop.



LEAF TOBACCO MADE UP IN "HANDS."

176. Relation to soil. It is advantageous for the corn planter to know that soils abounding in limestone generally call for the use of less phosphoric acid than lands in which it is wanting. Also, that highly colored, red lands generally contain much iron, and that when phosphoric acid is applied directly to this some of it forms insoluble compounds with the iron and is lost. This loss may be modified or overcome by mixing the phosphates with seed meals, stable manures, or other organic compounds before using.

177. Points for selection of seed corn. In addition to the general principles of seed selection previously described, seed corn selection, particularly in our climate, should be only of ears that hang down when ripened. Select also from stalks that bear only two large, uniform, well filled and well formed ears. White corns, as a rule, are more prolific than yellow varieties. The latter, however, have better keeping qualities, and the choice of the planter will depend on the crop being desired for immediate or future consumption. "Dent" corns, that is, varieties with an indented seed, are more robust growers and develop a better root system than the "flint" or smooth grained kernels. This is an important consideration in districts swept by typhoons. On the other hand, more moisture is apt to collect upon the uneven dent kernel and impair its keeping quality.

178. Insect enemies and remedies. Corn, in our country, is remarkably free from the attacks of enemies other than the locust and grain weevil. For the first of these preventive remedies have been suggested elsewhere. The latter are easily exterminated by exposing the grain in tight bins to the vapor of carbon bisulphid in the proportion of one kilo of the liquid to 100 cavanes of grain.

CHAPTER SEVENTEEN

TOBACCO

179. Effect of soil on leaf. While tobacco will grow in nearly all soils there is no other tropical agricultural product that is so greatly affected in quality by the character of the land on which it is grown. The best tobacco is produced on silts, fine porous clays, or river bottoms subject to occasional overflow. Many other lands, however, are well adapted to the cultivation of different grades. The market for these lower grades is very large, and their value much depends on the kind of cultivation given, and the methods employed in handling the leaf. These, as we will learn, are features entirely within the control of the intelligent cultivator.

180. Planting season. In our country tobacco can only be grown as a dry season product. It requires but a limited amount of moisture to perfect its growth, and a subsequent season of dry weather in which to ripen the leaf. Hence if good soil preparation is made in October, to conserve existing soil moisture, the showers of November and December generally suffice to mature the crop.

181. Preparation and care of seed bed. Tobacco seed is exceedingly small,* rather difficult of germination, and the beds whereon it is to be sprouted call for especial preparation. After marking off a suitable piece of level land it should be spaded or plowed up, and, while in a rough, cloddy condition, should be thoroughly burned. Burning is done by placing poles of dry wood on the bed, and on top of them building hot brush fires. The fires should be hot enough to thoroughly roast the soil to a depth of 5 or 6 cm., the purpose being to destroy seeds of weeds as well as the germs of any micro-organic diseases. After removing any remaining unburned fragments, the ashes and top soil should be worked down to an extremely fine, smooth, level surface. Previous to sowing the seed should be well mixed with about ten times its bulk of fine, white sand or white corn meal. The corn color will assist the planter to make an equable sowing and secure a more uniform stand of plants. The seed is not to be covered, merely pressed into the soil with a piece of plank or heavy board.

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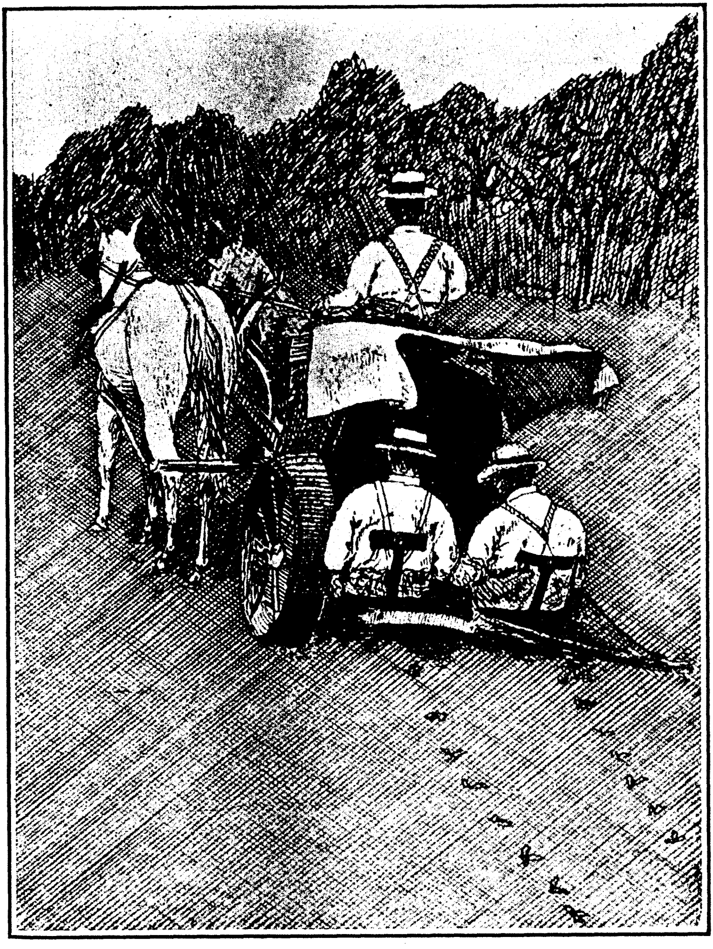
* A single gramme contains about 11,000 seeds. Making allowance for losses from all causes it is safe to count upon no more than 10 per cent of plants suitable for transplanting. Knowing the number of plants required, the grower has a basis for determining the size of seed bed and amount of seed necessary.



A TRANSPLANTING MACHINE.

The bed is now to be kept frequently sprinkled with water from a spray so fine as not to wash out the seed. Until the seed has sprouted, the soil surface should never be permitted to dry out. Continuous sprinkling can be avoided and moisture maintained by piling a thin shading of fine brush-wood over the bed. As the plants begin to grow this should be gradually removed so that, at last, they are entirely exposed to full sunlight. In five or six weeks the young tobacco should be large enough to transplant to the field.

182. Transplanting. The land to be planted, having been well plowed and harrowed, is now checked off as in the manner described for corn. The spacing distance between the plants will be 75 cm., or 1 meter, according as the variety is a slender or a robustly growing variety.

Transplanting is generally done by hand, although on large estates transplanting machines are used with great economy of labor and with as good results. The root of the young tobacco plant is fine, and, relatively to the size of the leaf, quite small. It is therefore essential to make the soil firm about the roots, and to give to each plant a half liter of water at the time of planting. Transplanting, except on overcast days, should only be done in the afternoon.

183. Details of cultivation. Cultivation should be frequent and thorough. Root cutting is to be carefully avoided. Although it does not seriously check the growth of the plant, it causes a fibrous, woody leaf of inferior quality and little value. When the plants have grown to good size, cultivation should be *towards* the plant. This is done with hand hoe, or a pony cultivator with two small, outer, plow-shaped teeth. This slightly "hills" the plants with a fine, powdery mulch of soil. The mulch holds the moisture below and checks leaf flagging in hot weather.

184. Manuring. The proper use of manure is probably the most important step in the cultivation of tobacco. The careful fermentation of the leaf (properly speaking, a factory operation) not being considered a feature of its cultivation. In order to satisfy the requirements of the plant, the grower should use manures that supply the three great essentials: phosphoric acid, nitrogen, and potash, in the respective proportions of three, five, and fifteen per cent each. The uses for which the leaf is intended, is another most important consideration in determining the *form* in which these manures are to be used. If a large, coarse leaf for cigar fillers is sought, then the nitrogen and phosphoric acid are applied in the organic form of animal manures and bone phosphates. If a thin, lustrous, elastic wrapper is desired, the needed elements are best supplied by means of the inorganic salts, the nitrates of soda or potash and the rock or mineral phosphates. A glance back will show that tobacco calls for great quantities of potash, more indeed than any other largely cultivated crop. Here also, the *form* in which it is used is of material importance to the planter. Nearly all the cheaper forms of potash are combined with common table salt.

Salt has in its composition large quantities of an element known as chlorine, and chlorine seriously affects the burning quantities of the leaf. For this reason kainit or muriate of potash, which abounds in chlorine, should not be used as a source of potash supply. Wood ashes in large quantities, or sulphate of potash in moderation, are two of the best forms in which this ingredient can be used. The excellence of our native tobaccos is mainly due to the fertility of the soil and its abundant supply of potash. Owing, however, to gradual soil exhaustion, there has been a steady crop decline per area, over that produced a few years ago.

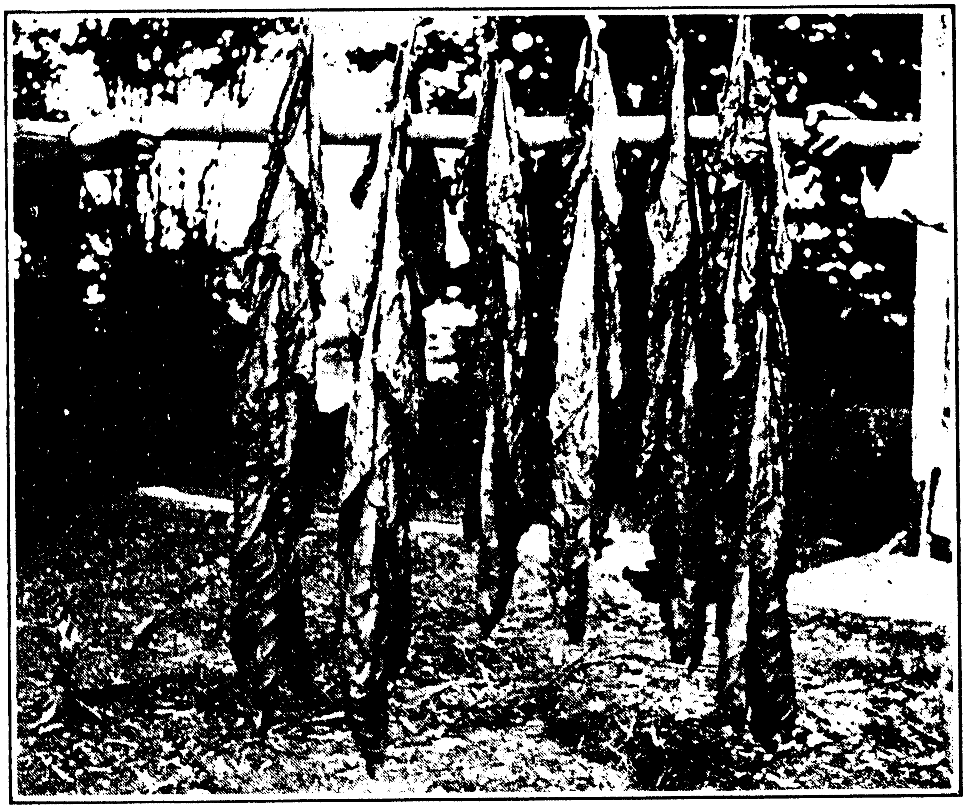
This in itself is an object lesson that serves to illustrate the constant necessity for the use of a well balanced, standard fertilizer.

185. Topping. Topping, or cutting back the stem, is the next operation called for. This should be done as soon as the flower shoot fairly develops. Here also the requirements of filler leaf or wrapper are to be considered. For the former, the plant is more heavily cut back, and fewer, but much larger, coarser and heavier leaves produced. For the latter, the plant is only slightly cut back. Topping for wrappers is a matter that can only be acquired by practical experience. From twelve to eighteen leaves may be left to the plant, but the correct number is determined by the health, vigor, and capacity of the plant. This condition is only revealed to the experienced eye. After topping, side flowering-shoots generally appear. These, too, should be suppressed whenever they develop.

186. Harvesting. Ripeness of the leaf is determined by folding it back. When it snaps, or retains a distinct crease after being folded, it is fit to harvest. A field when ripe will usually take on a slightly yellowish green color. This, too, is not readily detected by the inexperienced, but the test named above is a fairly good index, though the foliage may still appear quite green.

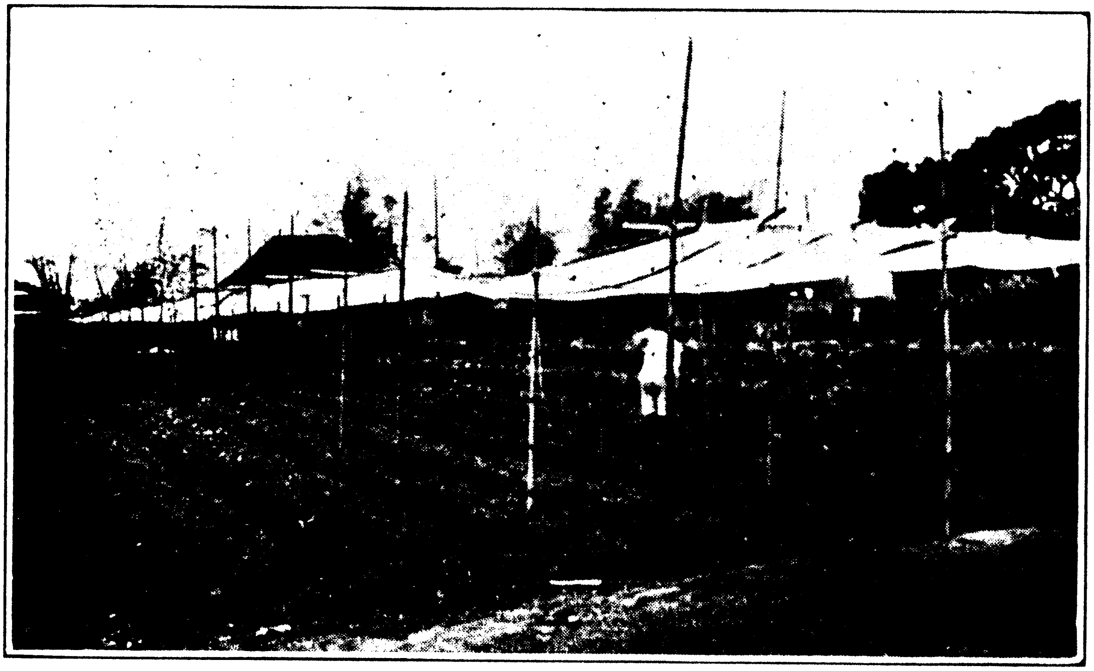
The crop is taken by cutting the leaves, one by one, or by cutting the whole plant. The latter plan is far the most expeditious and may be safely performed before complete maturity. The sap that remains in the stem is still capable of a feeble action, sufficient, however, to effect ripening. The stems when cut are partly split lengthwise, strung like wish-bones over laths or pieces of split bamboo, allowed to wilt for a few hours in the sun, and then suspended in the shade. Leaves nor stems should ever be cut until the morning dews have dried from the plant.

187. Curing and fermentation. Great care should be exercised in drying tobacco. Although it calls for abundant circulation of air, a fine grade is rarely cured within an open shed. The curing process should be gradual, and is best effected in well ventilated barns where the dessicating influence of hot winds may be controlled. Tobaccos previous to manufacture are subjected to fermentation. Upon this fermentation the color, texture, and aroma greatly depend.



HARVESTING THE WHOLE TOBACCO PLANT.

188. Culture under cover. Tobacco is now extensively grown in the United States, and to a lesser degree in Sumatra and Cuba, under a thin cloth cover. The picture shows it as grown in the Philippines under a roof cover only. This serves to break the force of the sun and improves the character



GROWING TOBACCO UNDER PARTIAL COVER.

of the leaf. In the best practice the field is completely housed in with cloth. This helps to maintain the close moist atmosphere in which the plant grows best, and it completely excludes night moths and other insects whose larvae inflict serious injury to the leaf.

CHAPTER EIGHTEEN

FORAGE PLANTS

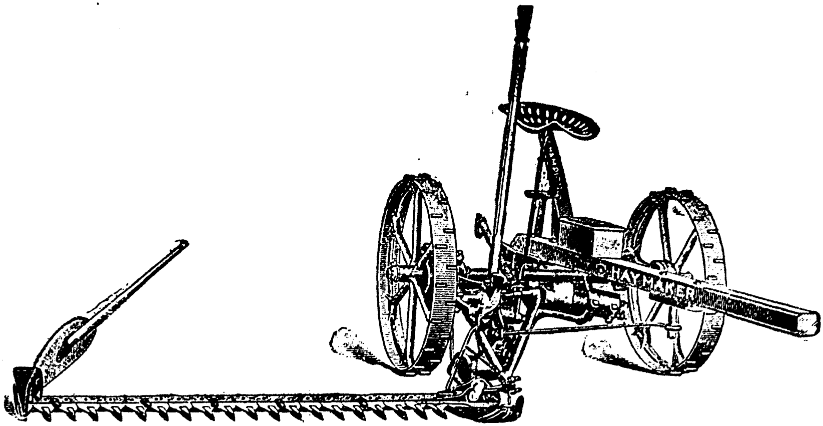
189. Definition and principal uses. Forage is the general name given to all food stuffs fed to live stock. For convenience, neither dry grains nor green pasture are included within this definition, and, as commonly used, it refers to plants that are cut and fed green, or that are cut and cured for future use. Forage is an indispensable crop on every farm where work animals are employed. Its production is also one of the most lucrative branches of agriculture that engages the farmer's attention. Local demand or shipping facilities to a more distant market are the factors that influence him in raising more than he requires for his own wants.

190. Varieties. The forage plants in most common use by us are *sacate* (a species of *leersia*), Bermuda grass, corn and peanut vine (*mani*). The curing of forage is so little understood by our farmers that these grasses are almost exclusively fed as green fodder. As the best animal condition results from feeding a ration that contains a large amount of dry forage, it is important that the farmer should understand the way of making it.

191. Bermuda grass. This is a wild, spreading, much jointed, often trailing perennial that is happily adapted to all soils and all exposures. Fed green or dry it is highly nutritious, its culture is the most simple, and it is capable, with good management, of producing many continuous crops. Its use should entirely supersede that of sacate, the semi-aquatic so extensively grown but so incapable of being converted into good, dry forage. Bermuda grass is the only good forage plant in our country that may be successfully cured during the rainy season. An occasional day or two of sunny weather is generally sufficient to effect this purpose.

192. Cultivation. Although a spontaneous product in fields and waste places, Bermuda grass is so mixed with weeds and inferior grasses as to be unprofitable to harvest as a wild product. It is best treated as a cultivated crop and kept under systematic cultivation. To accomplish this, the ground should be well and deeply plowed, and the surface harrowed down to the same state of tilth required by rice. Sowing may be done with seed, or, preferably with cuttings. For this purpose the long stalks (culms) are pulled as the children pull them when they gather this grass for horse feed. The stalks are now roughly broken into smaller pieces, and when no wind is blowing sown broadcast over the prepared land. A heavy roller is then passed over the field and planting is complete. The soil must not only be moist at planting time, but planting must be followed by immediate rains to secure a good setting. A greater assurance of a good stand is had by running very shallow furrows over the land. For this use a straight cultivator bar, to which 6 or 8 small shovel teeth are bolted about 20 cm. apart. The grass cuttings are then prepared and sown in the manner first described. Finally a drag or a light smoothing harrow is passed over the field. This process gathers the cuttings in the furrows and covers them with enough soil to prevent drying out. If a subsequent rolling is practicable it is further assurance of a good stand. If planting is done early in the rainy season within two months the ground will be covered with a good carpet of grass and to the exclusion of all other weeds and grasses.

193. Harvest. When beginning to flower, the grass should be cut and allowed to lie a few hours in the sun to wilt. Before noon it should be raked



A MOWING MACHINE.

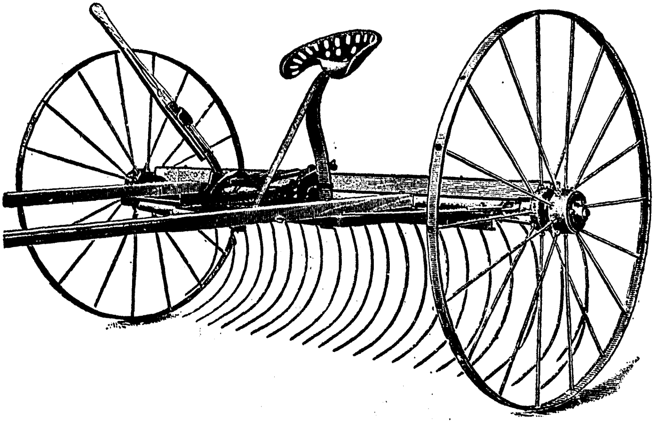
into light windrows and allowed to lie thus overnight. The next evening, while the hay is still warm, it is made up into heaps or cocks. One or two days thereafter, depending on the weather, it is cured sufficiently to be stacked under shelter.

No inflexible rule can be laid down for the curing of grasses. The end sought is to cock the grass while yet green enough to secure a *mild* fermentation. To obtain a good article the fermentation *must* be gentle.

If there is any serious manifestation of heat in the cock, which is easily told by thrusting in the hand, it must be thrown open and exposed to the sun. If rain occurs heating is almost certain to set in, and both windrows and cocks must be broken down until dried.

While stacking or storing hay, cheap, coarse salt should be sprinkled through it in the proportion of about 20 kilos to each metric ton of hay. Salt not only helps to preserve the sweetness and tenderness of the hay, but is wholesome and relished by all live stock.

If original soil preparation has been good at least two crops of Bermuda grass can be taken during our ordinary rainy season. If irrigation can be given, one or two additional crops may be secured during the dry season. If original soil preparation has brought the land down to a fairly smooth surface, it will allow of harvesting with a mowing machine. By its use only can large plantations of hay be expeditiously and economically harvested.


A HORSE HAY RAKE.

194. Leguminous forage. The value of this class of forage in our country can hardly be overestimated. It serves the double purpose of providing admirable animal forage, and of also acting as the best of soil renovators. Peanut vine (*mani*), the one most widely grown, is unfortunately the least useful of any for this double purpose. The roots are pulled in order to harvest the ground nuts, and the soil thereby deprived of much manurial benefit. The forage is too relatively scanty in quantity and on account of its coarse and woody nature is largely rejected by live stock.

In all respects, either cowpeas (*kibal*) or velvet bean are far more useful for this double purpose than peanuts. Their cultivation is most simple and they may be grown if desired as straight forage crops. It is more common and more profitable, however, to grow them in connection with corn. When so grown they are called "catch crops."

195. Cowpeas and velvet beans as catch crops. When corn is grown upon the system heretofore described, just prior to its "lay by" from cultivation, a furrow is opened down the middles between the rows and sown to cowpeas or velvet beans. Before the vines of the catch crop have grown sufficiently to interfere with the corn, the latter has ripened its grain and been harvested. Live stock are then frequently turned into the corn stubble to fatten on the catch crop. It is a better practice, however, to cut and cure the forage, and even the corn stalks may be cut and shredded by a machine made for the purpose.

VELVET BEANS.

196. A substitute for a grain ration. The harvest of cowpeas and velvet beans may be deferred till some of the pods begin to ripen and its value as forage greatly increased thereby. The seeds are rich in protein (muscle forming foods), and are greatly relished by all horned cattle. For work animals, not fed a regular grain ration, it affords one of the best single food stuff substitutes we have.

As a rule these plants can only be cured during the dry season. Their greater bulk and density than Bermuda grass requires more continued sun exposure than can be expected in the wet season. The curing process also calls for more care and must be very gradual. If wilted and dried out too rapidly and too completely, the foliage becomes brittle and breaks into a fine dust, leaving for the animal the stems, the most unpalatable part.

When properly cured all forage can be safely stacked under shelter. In our humid climate it is still better to press it into compact bales as soon as it has undergone its final sweating or fermentation. When so baled it is more convenient for carriage to market and not so apt to absorb moisture as when loosely stacked in bulk.

197. Fodder corn. This product calls for the same soil preparation as a grain crop. At planting time, however, the seed is scattered broadcast and deeply harrowed in, or drilled thinly in furrows only 25 to 30 cm. apart. This close planting quickly shades the ground, and if the original soil preparation has been thorough subsequent tillage is uncalled for. The crowding caused by close planting not only chokes out weed growth but diminishes the size of the stems. These, fibrous and woody at best, are still less relished by cattle when coarse and heavy. Corn fodder, whether to be fed green or cured, should be cut as soon as tasseled out.

198. Teosinte. This is a rank growing grass closely related to corn. Owing to its utility as dry or green forage for cattle, horses, or swine, together with its remarkable productiveness, it must be rated among the most profitable forage grasses that we possess. Naturally, like corn, an annual, it may be so treated as to produce a succession of crops from one planting. For the farmer's purposes it then becomes to all intents a perennial. Under the best conditions, four or five cuttings can be taken from a single planting and ten fold or more the quantity of better forage than can be cut from a like area in corn.

Teosinte will flourish on any good corn land, calls for the same kind of manures, similar soil preparation, and nearly identical cultivation as corn. In view of the enormous crop removals made every two months, it is evident that a large excess of manure is required over that needed to perfect a single crop of corn.

199. Planting of teosinte. Teosinte stools or suckers most abundantly, hence it calls for wider planting than corn. When the ground is in fine state of tilth, seed is thinly drilled in and subsequently thinned out so that the plants stand 20 to 30 cm. apart in the rows. In good soil the rows should be 1.2 to 1.3 meters distant from each other. At this distance, when mature, the crop should densely shade the land. The seed coat of teosinte is quite hard, and germination is assisted by soaking the seed in water for a couple of days before planting. Its early development is a slower process than the first starting of corn. It is more affected by drought and more easily choked out by weeds. On this account, in its early stages, it calls for frequent, close, clean cultivation. As soon as the plants completely shade the ground, cultivation is laid by. If more than one crop is to be taken, the plants must be cut before the flowering appears. If allowed to run to seed, the plant dies. Whenever a

A GOOD STAND OF TEOSINTE.

crop is cut the stems should be left scattered on the field for two or three days to protect the roots from the sun. In hot, sunny weather this precaution is most essential. The better the crop, the more densely has the soil been shaded, and unless this protection is afforded many of the root crowns will be killed by sudden exposure to the sun.

200. Harvesting and curing. Like velvet bean forage teosinte can only be successfully cured during the dry season. Owing to its great weight and bulk, it seldom requires less than three days of windrow drying, and a week or more of "shock" curing before it may be housed or baled with safety.

When a crop is taken as green fodder in the rainy season, the land at once should be well topdressed with a complete manure. It is then lightly plowed through the middles, using care not to work close enough to the rows to injure the roots.

Frequent, shallow cultivations are then in order till the grass is once more tall enough to lay by. Subsequent crops are prepared in the same manner.

If cropping is to be carried over into the dry season, irrigation is indispensable. This, of course, to be followed with cultivation as soon as the land will permit of entering with tools and animals. Teosinte calls for enormous quantities of moisture, but completely fails if exposed to stagnant water or continued inundation. It cannot be grown under such conditions unless provision is made for draining away the excess.

201. Rotation with other crops. It is possible, when using ample water, abundant manurings, and frequent cultivations to secure a long succession of crops from one seeding. The best practice, however, dictates that after three or four cuttings the field should be broken up, turned into leguminous crops, and then into upland rice or cotton before being brought again to teosinte.

CHAPTER NINETEEN

ABACA

202. Uses. Abacá is, primarily, a cordage fiber. Its most important use is in the manufacture of various classes of cordage, ropes, and cables. Enormous quantities of the fiber are used in the United States for making binder twine. Because of its lightness, strength, and durability manila hemp is considered superior to any other fiber for ship's ropes and cables. From the old and disintegrated ropes is made the well-known and valuable manila paper. In Europe, especially in France, many different articles of clothing such as shirts, vests, pantaloons, veils, crêpes, neckerchiefs, robes, and women's hats are manufactured from abacá. These materials are highly valued, both for their beauty and durability. The fiber is also used to some extent for upholstery, packing, and brush making.

In the Philippine Islands a considerable quantity of abacá cordage is manufactured, and the raw fiber is used without being twisted for all purposes where a tying material is required. Its most important local use, however, is for the manufacture of cloth. The native dress of both sexes in nearly all parts of the Archipelago is made from "sinamay," or abacá cloth. Looms are to be found in nearly every town in the Islands. The abacá fiber is frequently woven with either cotton or silk, in an almost innumerable variety of patterns. The fabrics made are of every degree of fineness, from delicate silk-like tissues to the coarse material used for fishing nets. With the introduction of fiber extracting and textile machinery there should be a largely increased demand for abacá as a textile fiber.

203. Soil requirements. This banana, the most important of all Filipino farm products, is usually grown as a wild or nearly uncultivated plant. Under careful and systematic culture crop maturity can be advanced fully one year, and the yield increased one quarter to one third over that generally obtained.

The plant thrives best in well watered, rich, volcanic soils, and in valleys partly screened from sun and completely sheltered from winds. Like the edible fruited bananas, its tender foliage is easily whipped and torn by high winds. In this respect, abacá is far more sensitive and, when so injured, requires a much longer time to recover.

FRUIT OF ABACÁ.

204. Need of shelter. Shelter, therefore, is a matter of the first importance, and unless the surrounding country fully protects the plantation, sufficient cane or* mango wind breaks should be planted. Sun shelter is not so essential, although moderate tempering of the sun's rays is beneficial. A very dense shade causes a drawn, spindling, and not very productive stem.

Abundant, well distributed rainfall is another factor in the best success. Failing this, provision should be made for irrigation.

205. Preparation for planting. Often, the richest soils and best shelter are found on the slopes of narrow ravines where a plow cannot profitably be employed. Here, contrary to general planting practice, alignment is disregarded and a plant site sought wherever it can be located. A bed a meter or more wide should be deeply dug for each plant and have well worked in the leaf mould and dead vegetation that usually accumulates in the bottoms of ravines. The beds should be so spaced that the distance of each from center to center is about three meters.

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* The common spiny bamboo *(caña)*, when planted in double rows, quickly makes one of the most effective wind breaks known. It also forms an almost impassable barrier to most farm animals. Its wide spreading roots make extraordinary drafts upon soil moisture and fertility. Nothing else will thrive within fifteen or twenty meters of it, and its planting is only recommended where land is cheap and abundant.

206. Rearing from suckers and seed. Plants are raised from seeds or, more commonly, from the suckers or offsets that spring from the root crown of the parent plant. Rearing from seed is a more tedious process, but is the way that increase on a large scale is most easily effected. The fruits are collected as soon as the seeds begin to turn dark. They are then cleaned from their surrounding dry pulp, and thickly sown about 2.5 cm. deep, in a well prepared, well drained, and shaded seed bed. The bed should be kept weeded and well watered until the seedlings appear. When these are four or five cm. high they are planted out in nursery rows, wide enough to allow of cultivation and about 15 cm. apart in the row. The nursery will require the same careful attention to weeding and watering that was given to the seed bed. If cultivation in nursery is of the best, in six months the young plants should be large enough to transfer to the field.

AN ABACÁ PLANTATION IN MINDANAO.

207. Transplanting. Abacá transplants so easily that the operation calls for neither experience nor special exercise of skill. It is a good practice, however, to remove with a sharp knife any roots that get badly bruised or broken in lifting the plants from nursery row.

When suckers are used for planting they are easily separated from the parent plant with a well sharpened spade. This should be driven down close enough to the main stem to secure a stub or bit of the root producing crown of the mother plant. If the soil is mellow and fairly damp at the time of planting watering is unnecessary. On the contrary, long continued rain immediately after planting, except in very porous soils, is sometimes a cause of decay and death. When growth is fairly under way water can hardly be given in excess. From this time, constant, clean cultivation should prevail, together with the use of the manures elsewhere recommended for the edible fruited bananas.

208. Harvest. The approach of maturity is indicated by a distinct change in leaf color and by the appearance of the handsome purple flower spathe.

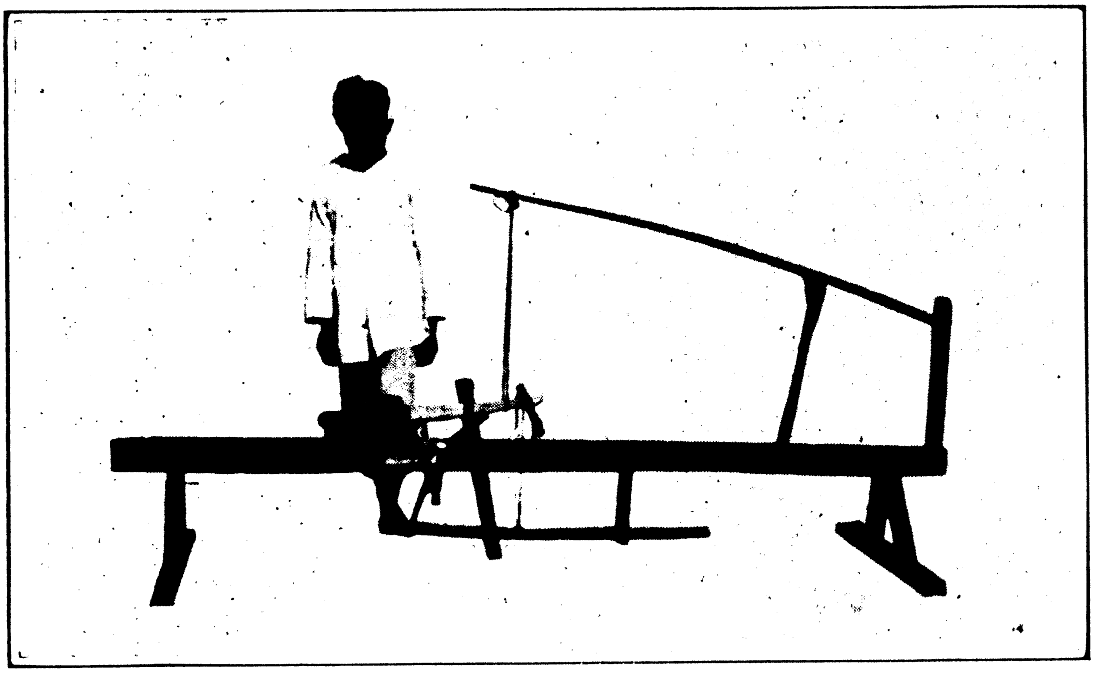
At this time the quantity and quality of the fiber is at its best. If permitted to ripen its seeds, the fiber deteriorates in quality and darkens in color. At this time the ripe stems are cut close to the ground, and with a sloping cut so as not to allow water to accumulate upon the stub and rot the plant.

209. Extraction of fiber. The extraction of fiber should commence within twenty-four hours after the cutting of the stalk. If left a longer time than this the fiber is liable to become discolored and weakened. As the abacá trunk is heavy and the fiber-extracting apparatus is light and easily transported, it is customary to move the latter from place to place and to extract the fiber near the spot where the plant is cut.

The trunk or stalk of abacá is often 12 or 15 feet long and from 1 to 1½ feet in diameter. This trunk consists of a small, central fleshy stem, 1 or 2 inches in diameter, around which are a large number of thick, overlapping layers, each layer being the stem or petiole of a leaf. The fiber is obtained from the outer portion of these leaf stems. The process of fiber extraction consists of two distinct operations: First, the removal of the ribbon-like strips of fibrous material from the leaf stems, and, second, the separation of the individual fibers by pulling these ribbons under a knife.

The laborer, sitting on the ground with a trunk of abacá across his knees, inserts under the bark of one of the leaf stems a small, sharp piece of bone called a "locnit," and pulls off a fibrous strip 1 to 3 inches wide and as long as the trunk. One leaf stem will yield two or three such strips. When these fiber strips have been taken off, the remaining fleshy material is removed and each consecutive layer is thus worked, down to the central stem of the trunk. The fiber obtained from the three or four outer layers, which are green and hard, will be coarse and dark colored, while that coming from the layers nearest the center of the trunk will be very fine and white. The latter is used for the manufacture of various kinds of cloth.

When a quantity of these fiber strips has been collected they are carried to some central point where a shed has been erected and an apparatus set up for stripping the fiber. The shed consists of a frame of bamboo poles covered with abacá leaves. The stripping apparatus, or "panguijan," is simple both in construction and in operation. It consists of a log set in a horizontal position 1 or 2 feet from the ground. On the top of this is fastened a block of smooth, hard wood. Over this block is placed a bolo having a blade about 1 foot long and a handle 1½ feet long. A rattan is attached to the end of the knife handle and connected with a bamboo spring above. Another rattan passes from the handle to a foot treadle. The bamboo spring holds the knife down upon the block, its pressure being easily regulated by lengthening or shortening the rattan. By means of the foot treadle the operator raises the knife when he desires to insert or remove a strip of fiber.



A NATIVE HEMP STRIPPING MACHINE.

In the process of stripping the operator holds in his right hand one or more of the fiber ribbons and also a short, round piece of wood. These strips are inserted under the knife and are drawn through with a quick, steady pull. The ribbon is then removed and reversed, the cleaned end being wound three or four times around the stick. This process of drawing under the knife removes all of the pulp or fleshy material, leaving in the hand of the operator a small bunch of clean, wet fiber. This is now hung over bamboo poles to dry and is then ready to market.

210. Machinery. The native hand stripping machines, while a subject for much needed improvement, possess features that *must* be embodied in any better machine. These are portability and suitableness for work in the field.

211. Manurial treatment. Every scrap of the refuse left from stripping should be gathered and distributed about the base of the growing clusters of plants. It is an excellent source of supply of the humus and humic acid essential to the best yield of abacá. It should not only be restored, but be strongly re-inforced with compost manures, stable sweepings, or rotting forest leaves.

CHAPTER TWENTY

THE COCOANUT

212. Soil and water requirements. Cocoanuts flourish best in a deep, free soil in which the thick, fleshy roots of the palm can freely spread. It also calls for not less than 2300 mm. of well distributed rainfall each year. With less water, or unless this requirement can be supplemented by irrigation, the very best success cannot be expected. Like many nearly spontaneous products, cocoanuts will exist under many soils and conditions and yield of their fruit, notwithstanding abuse and neglect. The best and most profitable results, however, are only to be obtained through an intelligent and well executed system of cultivation.

213. Seed selection. The earliest step begins with the selection of seeds from mature trees of known, good fruiting habits. The long time (six or more years) that elapses before trees come into bearing calls for especial caution in this particular. With a grain or other crop that matures in a few months a mistake in seed selection is always serious, but is soon remedied. With cocoanuts the disappointment is greater and the loss well nigh irreparable. The qualities sought are regularity of bearing, large production, excellence of meat, and great uniformity of size. These traits are inherited and seed selected from trees which have shown them over many years of observation are almost certain to produce equally good offspring. When perfectly ripe the seed should be cut, not allowed to fall, and be heaped up in some shaded, wind-protected corner until sprouted.

214. Nursery planting. When roots begin to thrust through the sprouted husks they are to be closely planted in shallow trenches for another year, or transplanted directly to the grove where they are to remain. The latter method, far the most expeditious and satisfactory, provided conditions permit, depends upon two conditions:

1. The successful exclusion of wild pigs, deer, and cattle from the grove.
2. Facilities for such good and complete tillage as will promote as rapid growth in the field as in the nursery trench.

If the land has been well and deeply plowed, the common practice of digging a large pit may be avoided. It is quite sufficient to open a hole large enough to admit the nut and cover it with 6 to 8 cm. of soil. Previous to planting, the grove is marked out with the same regard to perfect alignment that prevails in all good orchard practice. The tree is most fruitful if uncrowded and entirely exposed to sunshine and strong breezes. For this reason, very wide planting spaces and absence of wind breaks are recommended. Ten full meters apart each way is the least distance that should be allowed in soils of good depth and fertility.*

After planting the young sprouts are to be carefully tied to stakes to avoid accident from the careless use of plows or cultivators. It should be remembered that the cocoanut differs from most fruit trees in so far as it produces one and never more than one growing point or bud. If from any cause this is broken or seriously injured the plant dies

215. Intercalary crops. For three to five years after planting, interspace crops can be grown. Rice. camotes, and mani may be grown the first season provided that the vines of the last two are not allowed to encroach upon the young palm trees. After this hoed crops that call for frequent cultivation are the only intercalary crops that should be permitted. These also should be planted in such rotation as not to impoverish the land. Tobacco, by reason of the exceptional drains it makes upon the potash of the soil, is a most undesirable hoed crop to grow in connection with cocoanuts.

216. Manures required. Animal manures, green soiling crops, and the organic sources of nitrogen are the fertilizing elements most demanded in the early years of the plantation. From the fruiting age those in which potash predominates are most needed. No better home supply of potash exists than that abounding in the cocoanut husks. These decay slowly, even when plowed under, and should be pieced out with wood ashes, seaweed, or kelp if obtainable. Some of the cheaper potash mineral salts, such as kainit, are very useful. Kainit is combined with common salt to an extent injurious to many plants It has no injurious influence whatever upon the cocoanut. The press cake that remains after extracting the oil from copra will suffice to furnish the remaining plant food supplies needed to keep the grove in a highly productive condition. Inundation from flood waters is most beneficial, but stagnant water is always harmful and canals should be cut to drain away any that may collect.

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*In the Philippines many trees are planted at about 7 meters, and not uncommonly as close as 5 or 6 meters. This crowded condition accounts for the large number of barren or shy bearing groves.

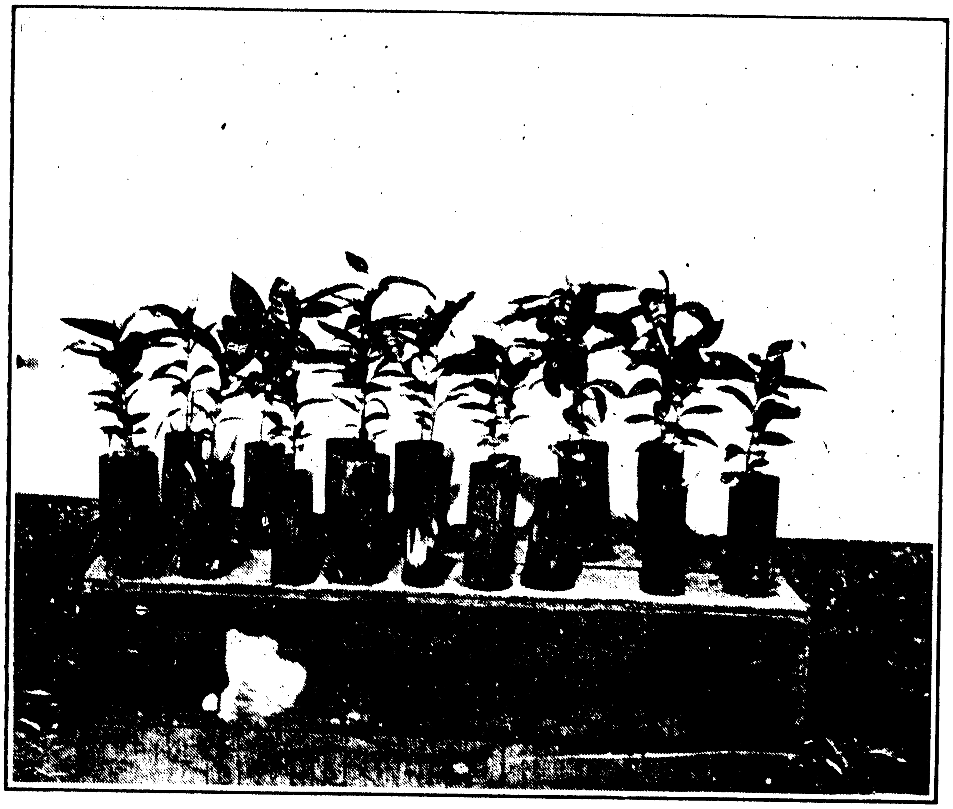
217. Harvest. For the harvest steps or "shoulders" are cut in the trunk by which the nut picker climbs. If these cuts are made only in ripe, hard wood, and the shoulders are cut with such a slope as not to collect rain water, the tree sustains no injury. The nuts may also be harvested with a double edged, hooked knife mounted upon an extension handle. This is made of slender bamboo tubes that nest or fit one within the other and which may be extended to the required length. The steps, nevertheless, are useful as a means whereby the tree nesting, nut eating rat is dislodged. They are also useful for the control of the big rhinoceros beetle that attacks the immature wood.

218. Insect enemies. These beetles and their larvae bore deep holes into the tender wood where it is clasped by the great sheathing leaf stems. Where these insects abound, and are unchecked, they often destroy a large tree. They may be extracted by means of a stout wire, one end of which is sharpened and bent into a stiff hook. An excellent preventive remedy is to place a few handfuls of clean, sharp sand in the axils of the leaves. As the insect bores the sand flows in. Its constant attrition irritates and injures and deters the insect from further boring. It is only in localities where the tree nesting rat is a serious pest that the dead leaves should be removed from the tree. They protect the tender, underlying wood till hard and mature enough to resist the attacks of the beetle.

CHAPTER TWENTY-ONE

COFFEE

219. Seed selection and sowing. A coffee plantation is best raised from seed grown in an open seed bed and thence transplanted to its permanent site. The seeds should be fresh and from trees free from disease. They should have the outer pulp removed, but not the inner skin or parchment that surrounds them. Seed sowing should be done in beds that have been deeply spaded, and into which has been worked a good supply of well decayed manure or forest leaves. The seeds are then sown in rows 50 cm. apart and covered 4 to 5 cm. deep with the light, finely pulverized soil of the seed bed. If planted early in the rainy season, a year later, they should be 40 to 60 cm. high, according to the variety. This is an excellent size for transplanting. When the seed bed is completed it should be covered with temporary slat or bamboo screens that may be removed during long periods of cloudy weather. If water can be supplied in dry weather it will greatly encourage growth. Water, however, may be dispensed with if the initial preparation of the bed has been



SEEDLING COFFEE PLANTS GROWING IN BAMBOO TUBES.

Coffee was formerly grown in a half wild, uncultivated state. Since the outbreak of serious infectious diseases it may no longer be grown as a semi-spontaneous product. It can only be produced by cultural methods that will permit the planter to successfully cope with the disease.

good, and has been followed with careful, subsequent tillage. This, in connection with shading, and, if necessary, a generous mulch of leaves or fine grass should carry the plants in good health through the dry season.

220. Marking. Previous to transplanting the land should be well plowed and harrowed. It is then to be carefully lined out in two directions at right angles to each other. This will mark the land off in small squares that may be further subdivided by running diagonal lines across them. At the point where these intersect a fifth plant may be set. This is not only the most economical use of the land, but as the trees will align in all directions it permits of cultivation with animal power.

Tree markers are now to be set, and the distance at which they are set will depend on the variety to be grown. The large, robustly growing Liberian berry should not be nearer than four meters, while the Arabian may be set at three or slightly under. The hybrid varieties are planted at an intermediate distance.

221. Hole making. Holes are next dug to receive the young plants. These should be at least 60 cm. wide and fully as deep. At that depth, if an impervious hardpan is encountered, it should be shattered with a charge of blasting powder. The soil taken from the holes should be thrown into two heaps. In refilling them the soil taken from the surface should be thrown back first, and that from the bottom used to top off the hole. These instructions apply only to stiff, tenacious soils underlaid by hardpan. In free, deep, mellow soils that have been properly broken with the plow the expense of hole making may be entirely dispensed with.

222. Transplanting. The young coffee plant is easily handled and the directions laid down for its transplanting cover the rules to be observed in moving most young evergreen trees. Fully a month before digging from the nursery, watering or cultivating of the seed bed should be suspended. At the same time, gradual removal of the shading should begin. This latter operation should be so timed that for two weeks before digging the seedlings are fully exposed to the sun. Whenever enough rain has fallen to put the land in good condition transplanting may begin.

223. Correct planting conditions. Good planting condition means plenty of moisture in the soil, but not so much as to cause it to clog or stick to a bright spade or shovel. Planting in muddy or pasty soil is always to be condemned. When soil conditions are good, removal of the young plant from the seed bed with a ball of soil about the roots is quite unnecessary. Previous to removal the seed bed should be saturated with water, the plants carefully dug so as not to break many roots, and laid with root ends together upon a piece of wet sacking. When a sufficient number are collected, they are to be completely rolled up in the sacking and taken to the field. The bundles should be small, and so packed that in unrolling only one at a time is exposed to sun and wind until planted. Planting, except on overcast days, is best performed in the afternoon when the sun has well declined from the meridian.

Two or three days before planting the holes are refilled in the manner previously described in order that the soil may become settled, but not compact. With a trowel the planter now re-opens them large enough to receive the spread-out roots. These are now covered with soil and given sufficiently heavy hand pressure to force soil and plant far enough down to bring the root crown of the latter nearly to the level of the surrounding land. The intention is to leave the root crown at, or a mere trifle above, the surface. This makes allowance for subsequent rains that may be expected to settle the whole soil mass a little deeper. Deep planting is detrimental to most plants. To inter the stem of a coffee tree only 4 or 5 cm. deeper than it stood in the nursery row, is to retard its growth and sometimes results fatally. If it is convenient to give to each plant a half liter of water at the time of planting, the operation may be carried on during the most sunny weather. Failing this, to remove a few of the tenderest leaves will retard evaporation and aid in procuring a good stand. The young plant is now to be snugly tied to the marking stake and the planting process is complete.

224. Intercalary crops. During the first twelve to eighteen months after planting, successive crops of corn, cotton, tobacco, mungos, bush beans, or other hoed crops may be grown between the rows of coffee. The returns from these will compensate for the clean, close cultivation that the coffee should continuously receive.

225. Manuring. Until the bearing age (two and one-half to four years) nitrogenous manures should dominate for the purpose of securing rapid growth and early development. When fruiting begins they should be supplemented with manures richer in potash and phosphoric acid. All the pulp and parchment from the berries should be saved and returned to the plantation. This, compounded with wood ashes and ground bone, will be found an excellent domestic fertilizer.

226. Shading. In our latitudes Arabian coffee, if planted within 300 to 350 meters of sea level, will thrive better when slightly sheltered from the sun. For this purpose "madre de cacao" is used and recommended. Stout cuttings or branches of this wood, if planted when freshly cut, will easily take root and furnish shade at the hottest time of year. The cuttings should be set at intervals of 10 meters in the rows. This will not impede the annual plowing and frequent cultivations that the grove should receive. Shading the Liberian or any other of the strong growing varieties is uncalled for at any time or at any elevation.

227. Pruning. Pruning the Arabian species is confined to the removal of water sprouts, of dead or injured branches, and to the occasional pinching back of leading branches. This last is only called for when the tree is furnished with an insufficient number of fruiting limbs. The strong growing species should be sharply headed back at a height of 2 to 2.5 meters. This will promote a branching habit and greatly facilitate harvest of the fruit.

228. Diseases. Of diseases mention has already been made of the leaf spot, and attention been directed to the use of fungicides and good, generous culture as preventive measures. Of other enemies, the grub of a large beetle often feeds upon the roots of young plants. Its attack is disclosed by a change from the dark, lustrous green color of a healthy leaf to a dull yellowing green. The grub of a small beetle also enters the tree from the root, boring its way upwards and honeycombing the wood in its passage. These enemies are easily controlled. The remedy is to open a small hole in the soil close to the stem of the affected plant till the topmost roots are exposed. Then, with a graduated glass syringe, squirt five to six grams of carbon bisulphide and immediately close the hole with moist soil. This remedy is unattended with risk provided the dose is regulated to the size of the subject. For a very small plant it should be slightly reduced, and for a very large one may be more than doubled with impunity. This treatment, to be most effective, calls for a study of the life history of the insect in order to apply the remedy while the larvae are in their earliest stage and before boring has fairly begun.

Used with discrimination, the bisulphide is a positive specific in these diseases.*

229. Relative value of varieties. The Arabian is the most highly esteemed of all coffee berries, yet it is the most difficult to grow and by far the most susceptible to disease. Other coffees, however, when well prepared are in very great demand. Their excellence, as compared with the Arabian, largely depends upon the skill with which they are handled and the methods of fermentation used to develop their best qualities.

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*Carbon bisulphide generates a highly inflammable and explosive gas. It should not be brought near flame nor its use entrusted to careless workmen who smoke.

CHAPTER TWENTY-TWO

CACAO

230. Uses and climatic needs. Cacao is the tree from whose seeds the chocolate and fats so highly prized in cookery, confectionery, and medicine are made. An extremely tropical plant, it will not reach its best at altitudes where the night temperatures often fall below 15°C. A lover of moisture as well, it thrives best in a close, damp atmosphere and with abundant water at the root. To meet the former requirement it should be planted in sheltered valleys shaded from direct sun and screened from high winds. For the latter requirement regions favored with abundant rainfall or with facilities for irrigation are selected.

231. Soil and moisture requirements. The roots of cacao run deeply downward and this implies the necessity for a deep, porous soil. In shallow soils it will grow and bear fruit, but in a few years the tops begin to die back. When this occurs the usefulness of the plant rapidly declines.

With all its love of moisture, which can hardly be in excess, there is no plant to which *stagnant* water is more quickly fatal, and the planter will act accordingly to secure the perfect drainage essential to success.

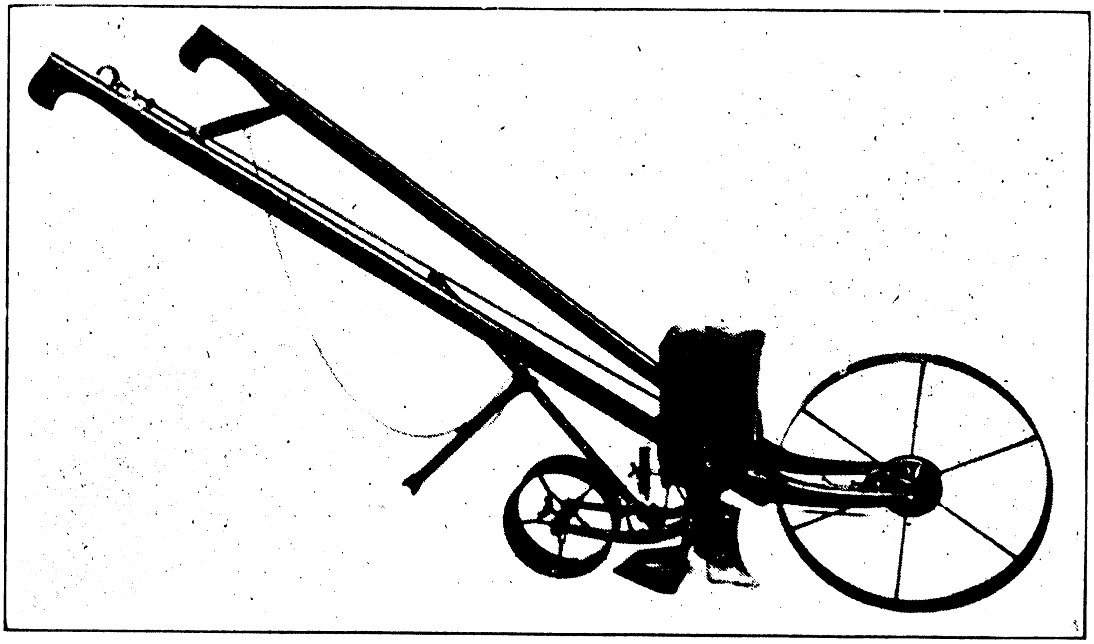
Like all other orchard crops, cacao responds to continued, high class cultivation by vigorous growth, early maturity, and productive crops.

232. Seed sowing. As better varieties of cacao, unlike the cocoanut, are capable of being increased from bud or graft, seed selection need not be carried beyond securing fruits from robust trees, free of disease. Fruit pods are gathered while still a little immature, the seeds removed so as not to bruise them and exposed for two or three days to flowing water or water that is frequently changed. This facilitates the easy removal of the sweet pulp that surrounds them, which, if left, invites the attack of ants and causes fermentation and decay.

Owing to their short-lived vitality the seeds are immediately planted in beds prepared in the manner recommended for coffee. Seed bed treatment differs from coffee in so far as good cultural treatment only will not tide cacao through an ordinary dry season. The seedings *must* be watered if a healthy, vigorous growth is to be obtained. Transplanting operations require the exercise of more care and skill than coffee. However good the soil conditions, a little water should be given at the time of planting and the young plant screened for a few days with a bit of banana leaf.

Owing to the greater delicacy of the cacao it is advisable for unskilled planters to rear the seeds in short bamboo tubes. These are hauled to the plantation, easily split open with a bolo, and the ball of soil with roots intact easily transferred to the hole made to receive it. In planting from tubes precautions about watering and shading the young plants are unnecessary.

233. Temporary and permanent shading. Preparations for temporary shading with banana plants should be made some months before transplanting and permanent shade trees introduced into the rows of cacao when their planting is completed. For shade trees, plants of the legumes family only should be employed, and for our country there is probably nothing better than the rain tree. This grows to large size, and if the lower branches are pruned away, and the top heavily cut back at 10 to 12 meters, it will throw out a leafy, spreading screen far above the top of the tallest cacao. In



HAND SEED DRILL. CAN BE ARRANGED TO SOW LARGE OR SMALL SEED NEAR OR FAR APART.

good soils the rain tree will need to be planted in every fourth row and at intervals of 16 meters in the rows. The rows of cacao should be 4 meters apart and the plants a like distance in the row.

234. Care in cultivation. The best cultivation should be given whenever soil conditions will allow, and, as in well prepared land, the roots will mostly descend, plowing closely to the tree is both safe and beneficial. The utmost care should be used in all cultural operations, however, to see that neither stem nor bark is bruised in the slightest. As a precautionary measure, the ends of the whiffletrees should be well protected with rubber or other soft packing. The wood of cacao is soft and spongy, and when wounded and exposed to damp quickly becomes the prey of fungus disease and insect enemies. For a like reason, when pruning, only clean, smooth wounds should be made, so that rain water cannot collect upon the stub.

CACAO BEARING FRUIT.

235. Special pruning. Pruning, aside from a knowledge of the principles laid down elsewhere, calls for an especial study of the fruiting habits of the plant. The flowers, and subsequently the fruits, break from small buds that develop only on the main stem, or on ripened branches of two or more years' growth. The aim of intelligent pruning, therefore, is to develop and carry just such a number of straight, healthy branches as the tree can fully mature, and to sufficiently thin out to admit the light and air essential to maturing the fruit.

A stunted, diseased plant will occasionally form flower and fruit in its second year. One that has been kept under high pressure growth will rarely develop either till the third. In either case it is advisable to remove the fruit as soon as formed and center the energy of the plant upon the manufacture of leaf and wood.

Fruit should be taken from the tree with shears or clippers. The point of its attachment to the stem is the seat of development of all future flowering. If, therefore, the fruit stem is pulled or torn away from the bark, it carries with it some of the bud points of future crops and diminishes by that much the fruiting surface.

236. Insect enemies. Cacao is subject to the attacks of plant lice, to a scale-like mealy bug, to wood-boring beetles, to a night flying moth that deposits its eggs on the fruit, and to a fungus disease known as canker. As this last disease has not occurred here remedial measures other than the preventive one of good culture need not be considered. The first two are easily controlled by a ten per cent spraying mixture of kerosene in water; the boring insects are killed by carbon bisulphide, and the moths may be trapped in thousands in a flat vessel of water on which floats a thin film of kerosene, and above which is suspended a brilliant acetylene gas lamp.

237. Manurial needs. Cacao makes fewer drafts upon soil fertility than most tropical cultures. If the empty fruit pods are plowed under and all tree prunings burned on the ground, there is need only to restore to the soil the equivalent of plant food carried away by the seeds. Roughly speaking, the seed crop consumes about two units of nitrogen to one each of potash and phosphoric acid, and restorations should be made in about that proportion.

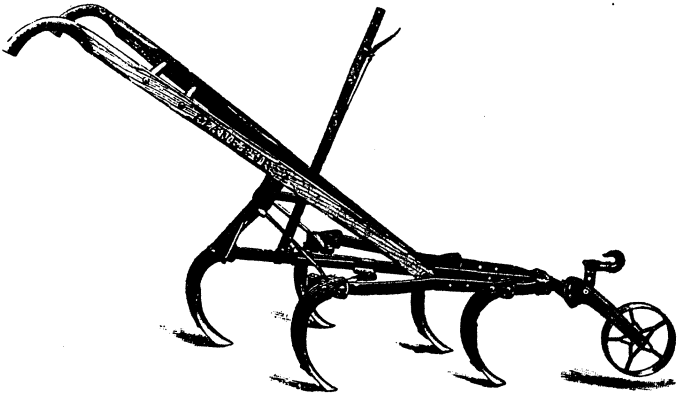
Cacao, like coffee, before being available for commercial uses, requires to undergo careful fermentation and other finishing processes. These are operations for the factory, not the farm, and do not call for consideration here.

CHAPTER TWENTY-THREE

ORCHARD FRUITS

238. Relation to soil. Our orchard fruits, with the exception of bananas and cocoanuts, are borne by plants whose roots naturally descend downwards, and consequently call for deep, open soils, or such soil preparation as will best meet the root requirements. Some fruit trees of great size and exceptional vigor, like the rima and mango, will grow in scanty soil overlying soft rock. They are apt, however, to cast their fruit before maturity and seldom equal the yield of those grown on deeper soils. Some fruits, the lanzone and mangosteen for example, positively refuse to produce if planted over a hard pan near the surface. By digging a shallow hole, and then shattering the hardpan with a high explosive, the roots of these trees are enabled to explore the cooler, moister depths below and become productive. A like practice will increase the yield of other kinds of fruits in localities where they are now barren or nearly so.

239. Effects of cultivation. All fruit trees are benefited by frequent, clean cultivation. This is clearly shown in the better general health and greater fruitfulness of the isolated trees occasionally seen in cane, corn, or other well tilled fields over those in adjacent orchards which have always been neglected.



THE BEST STYLE OF LIGHT ORCHARD CULTIVATOR.

240. Manures to use. Quantity and quality of fruit may be greatly increased by the use of manures. In many parts of the world the use of nitrogenous manures that stimulate a rank growth of succulent leaf and wood must be used with great discretion. Here, however, the conditions allow of a continuous forcing process, at least until the tree comes of bearing age. Until that time, we may use stimulating manures with a free hand. Nevertheless, the principle holds here, as elsewhere, that good and abundant fruit is the product only of ripe, well-seasoned wood. Therefore, from the fruiting age forward, we use manures in which potash and phosphoric acid predominate, as these are the elements of plant food best adapted to bring about those conditions.

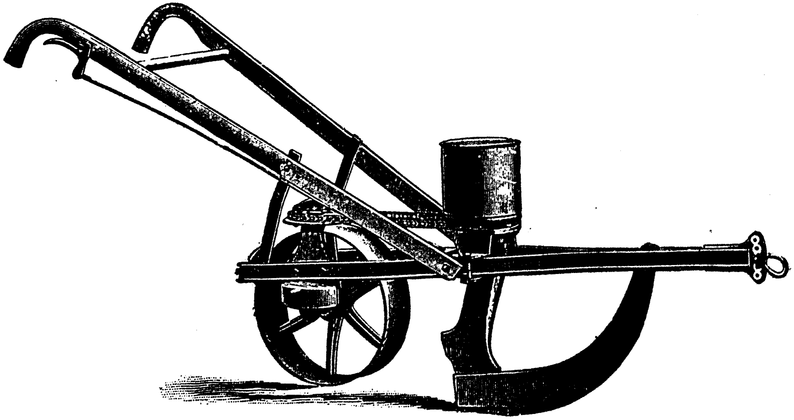
241. Banana as an example. The common banana will furnish a good example for experiment. If a young plant be well manured with nitrate of soda and stable manure, it will make a phenomenal growth, but its fruit will show no marked difference from the ordinary. If an adjoining plant be treated in the same manner, and be given in addition a few handfuls of any good acid phosphate and unleached wood ashes, it will show a remarkable gain in size and weight of its fruit bunch over the first. Some fruit trees have traits not common to all kinds and the most suitable treatment for each may not be included within general rules of guidance.

242. The mango. Mango trees call for a prolonged period of rest. Consequently, they are most productive in districts where there is a well marked dry season, and freedom for a time from the stimulating influence of water. The farmer can assist in bringing about these conditions by forcing growth early in the rainy season, by the use of manures, and frequent cultivation. Toward the end of the rain monsoon the ground should be plowed while so wet as to turn up in sticky, bad condition. Left in this state it will rapidly bake and dry and bring about the desired state of suspended animation. In regions unmarked by distinct wet and dry seasons the check to growth may be effected by severe root prunings.

243. Citrus fruits. Oranges, cajeles, lucbans, pomelos, and lemons are more productive if pruned to a single stem than in the bush form so commonly seen. The bush form is the result of suckers or water sprouts that have sprung unchecked from the root crowns. They attract an undue share of the sap and, pending their development into a fruit bearing stem, the fruit bearing of the rest of the tree is diminished.

Thinning out the fruits of citrus trees while small and immature is an excellent practice and specially to be recommended for the often overladen naranjita. The fruit that remains is mostly of a size and quality that commands a readier sale, and at a price much greater than to cover the labor expended in thinning.

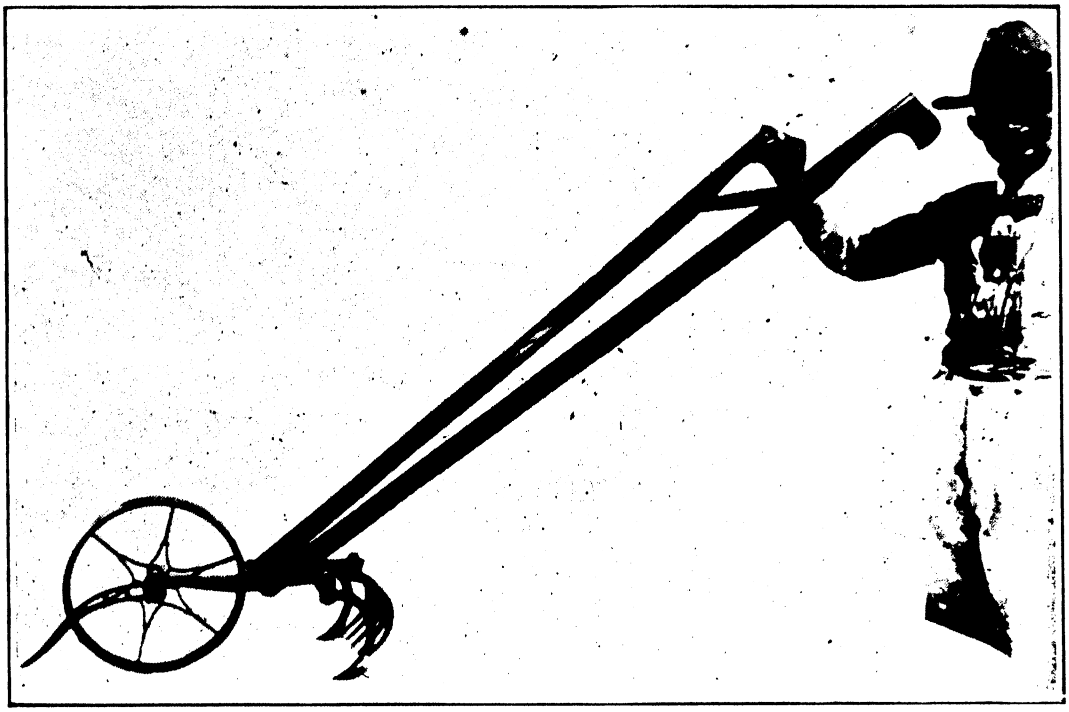
244. Minor fruits. Among some of the best of our minor fruits are lanzones, ciruelas, chicos, santol and ates. It sometimes happens that a tree of one of these is found that produces larger, finer, and better flavored specimens than any in its vicinity. It is suggested that the student make careful comparative notes of the habits of the trees in his neighborhood, and when he has found any superior to its fellows that he select from it buds, scions, or layers for propagation. This will afford him useful practice in the art of propagation, cultivate keen powers of observation, be a benefit to himself and confer a lasting and elevating influence upon the horticulture of the country.



A ONE HORSE CORN PLANTER.

THE VEGETABLE GARDEN

245. Three essentials. The secret of success with vegetables consists in timely sowing, good soil preparation, and future good tillage. Some garden vegetables may be planted at all seasons of the year. With such, timeliness, of course, is a minor consideration. Some varieties of squashes, as well as eggplants, sweet corn, okra, lettuce, radishes, and beans belong to this group.



LIGHT HAND CULTIVATOR FOR FIELD OR GARDEN USE.

In general, garden vegetables grow best and are most fruitful during the dry season, but we must not assume from this that soil moisture may be dispensed with. The amount of water required will depend on the quick or tardy development of the variety grown.

Radish will sometimes be fit for table in 20 days. Lettuce may head out in 30 days. Okra and American squashes make serviceable fruits in 35 days, and string beans in 35 to 42 according to the variety sown. On well prepared soils, reasonably retentive of moisture, it is, therefore, practicable to raise many vegetables without irrigation.

246. Planting time for exotics. Most exotic vegetables flourish best if planted so as to ripen during the cooler weather that prevails in December, January, and February. This is due to the fact that most of these have their origin in cold or temperate countries and that the relative coolness of our dry season more nearly approaches the conditions of the growing season in their original homes.

Cabbages, kale, onions, beets, carrots, spinach, and turnips are good examples of these, and, in a lesser degree, eggplants and tomatoes. These all require from two to four months to perfect their fruits; hence, in general, a favorable planting season is found in the months of October and November. At that time, in those districts marked by a well defined dry season, there usually are enough rain showers to so advance growth that the plant will reach its maturity during the succeeding coolest months.

Quantity, size, showy appearance and good keeping qualities are the ends sought by the market gardener; but flavor and tenderness should be the objective points of the grower for home use. In the tropics, these are qualities which can only be secured by "driving," that is, by such generous and constant tilth as will force the plant to early maturity. This applies with emphasis to kale, spinach, mustard, lettuce, endive and parsley; plants that are eaten raw as salads or cooked for greens.

It is also more or less true of many roots (beets, carrots, turnips, and radish), which become tough, fibrous and unpalatable if exposed to any serious check in their growth before of size to pluck.

247. Care of root vegetables. In general, the planting and subsequent care of root vegetables is the same and as follows:

The seeds are best sown in shallow furrows, or, preferably drilled in with any of the simple and excellent devices made for this purpose. The essential to success is such a fine well prepared surface that the seeds may be planted shallowly and still find sufficient moisture to sprout. More seeds are killed by too deep planting than by any other cause, and it is always best to defer planting until the surface has been wrought down to such a fine finish that surface moisture is near at hand.

248. Depth to plant seeds. Deep planting is a relative term and depends on the size of the seed used. Carrots, turnips, mustard, and lettuce have small seeds; beets also, although the aggregate fruits of several beet seeds that we sow seem large. These should never be covered more than 25 mm. and 20 is still better. Radish, spinach, melons, cucumbers, and okra have larger seeds and can be safely planted any depth from 25 to 50 mm. Beans, peas, and sweet corn, we describe as large seeds and may be buried from 50 to 100 mm. without injury. Much depends upon the exercise of good judgment in seed sowing, and the extremes of deep and shallow planting should be governed by the nearness of moisture to the surface, fineness of soil and indications of rain.

Garden roots require a rich, free, deep soil unimpeded by stones or gravel. The seed should be planted or drilled in shallow furrows about 30 cm. apart and, when conditions are favorable, the young plants should peep through the soil in 4 to 10 days thereafter. If the soil forms a crust subsequent to a shower of rain, it should be lightly stirred with a wheel or garden hoe, in order to conserve the moisture.

When the young plants are large enough to handle, they should be thinned out to stand 6 to 8 cm. apart in the rows. In thinning, always use both hands. With the thumb and forefinger of one hand pressing down and holding in place the selected seedling, and with the other hand pulling all of those nearby.

249. Crops of slow growth. In planting crops requiring several months for their development the best practice is to sow in November and December. During these months there is usually sufficient rainfall to promote good growth until the fruiting season approaches.

At this latter time, much moisture is detrimental, as it tends to make leaf and stem instead of the desired flower and fruit. Melons, cucumbers, peppers, tomatoes and eggplants* are good representatives of this class.

250. Transplanting. Some vegetables, such as cabbages, tomatoes, eggplants and peppers are positively benefited by transplanting. The root pruning they receive promotes a stocky, compact growth and early maturity. To effect this the seeds are sown in shallow boxes or carefully prepared seed beds which have been shaded from the direct rays of the sun. When 10 to 12 cm. high they are dug and then transferred to the field or garden. Before transplanting the shading should be gradually withdrawn so as to harden the plants before removal. Transplanting is best performed during overcast weather or late in the afternoon, and, if possible, about half a liter of water should be given to each plant at the time of setting out. Firm, solid planting is an essential to success. A principle is involved, which is, that exposure of the root to a drying air until it has re-established its activity, will result in death. Here, too, the use of judgment is required. Do not pound or tread the soil until it is such a compact mass that the new rootlets cannot penetrate it, nor, on the other hand, pat or settle the soil so tenderly that the volume of included air is great enough to dry and wither up the root.

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* An exception occurs with the native eggplant, which may be grown at all seasons. The improved American varieties are apt to drop their fruits under the influence of long-continued rains.

TEOSINTE GROWN FOR SEED, SHOCKED IN THE FIELD TO RIPEN.

251. Tomatoes. Tomatoes are most productive upon strong loamy soils, but must be staked and tied up to keep the fruits from decaying. In the dry season, on light sandy soil the fruit will seldom rot and staking may be avoided. When rain or much humidity prevails, the fruits of tomatoes should be harvested when fully grown but not ripe. If wrapped in dry paper and placed in a cool, dark room, they will color beautifully.

252. Cabbage. Cabbages require a strong rich soil. They are gross feeders and call for abundant supplies of stable manures and nitrogen. The latter is found in the commercial fertilizers (nitrates) sold in the markets and in good supply, in slaughter house waste, fish offal, etc. If these are not available, by all means, first raise a few velvet beans, "kibal" or other nitrogen gatherers on the piece you wish to put in cabbages.

The cabbage is extremely subject to the attack of two species of worms. One is the larva of a small butterfly that works deeply into the heart of the vegetable. It can only be kept in check by frequent dusting of the young leaves with Paris green. The application should be made upon the appearance of the first small hole in the leaves. If neglected till the worms have worked into the heart of the cabbage, the remedy is quite useless. The other serious enemy is a cut worm, which works at night upon the foliage, and during the day withdraws and hides in the soil at the stem of the plant. They may be dug out of the ground or trapped by placing a mulch of green weeds about the stem under which they will crawl for the coolness and protection from the sun.

253. Cucurbits. Cucurbits (melons, some squashes, cucumbers, and pumpkins) vary much in their requirements, some varieties faring well at all seasons, some during the wettest and others during the dryest times. In general they thrive best in the interior valleys remote from the influence of sea air. Some success has followed the planting of American melons on light soils that are thinly shaded from the sun rays by a sparse undergrowth like abroma. A light artificial screening will of course answer the same purpose. Melons when young are very susceptible to the attacks of leaf-eating insects (squash bugs) and to a bacterial disease known as "wilt." For the latter there is no specific remedy yet known. The former are controlled by hand picking and the arsenical treatment described elsewhere.

254. Beans. Beans are successfully grown at all seasons. During the winter (dry season) they are sometimes subject to a mildew due to the greater daily range of temperature than occurs during the hottest season. The disease may be checked by occasionally dusting the plants with flour of sulphur.

255. Asparagus. Asparagus is well and profitably grown in the tropics. The seed is hard and should be soaked in water for 2 or 3 days before planting and then drilled in rows wide enough to admit of cultivating with a hoe. Until one year old the plants should be kept well watered, cultivated and manured, and are then to be transplanted. Transplanting is done at the beginning of the rainy season in trenches 20 cm. deep and quite 80 cm. apart. The bottom of the trench should be worked up deeply with old stable or corral manure, and the roots planted so that the crowns will be flush with the bottom of the trench. In transplanting, all of the old top should be removed to within 2 or

3 cm. of the crown. The trench should not be filled up, except as gradually will occur from the washing of rain, and the cultivating of the ridges. The trenches should be well watered during the first dry season until within two months of its close and then allowed to bake and dry out. By the time that rains fall the tops should be well ripened and are to be cut back closely to the ground. The trench is now to be completely filled with soil to which more manure has been added, and within one month thereafter, cutting may begin and continue throughout the rainy season. The future success of the bed depends upon the good ripening of the tops during the latter part of each succeeding dry season and the annual application of a heavy top dressing of good barnyard or stable manure. Being a maritime plant, asparagus is benefited with an occasional dressing of ordinary table salt.

Parsnips, Brussels sprouts, salsify, celery and French artichokes have been produced in the tropics, but hitherto with such indifferent success as not to call for details of their culture here.

256. Ants. The depredation of ants is a serious obstacle to the garden-maker in many localities. Where gardening is done upon a large scale, the only practical remedy is to take the tract in hand quite three weeks before required for planting. It then should be well plowed, and thereafter deeply cultivated every second or third day during that period. This constant disturbance is such an annoyance to the pests that most of them will abandon the spot for undisturbed territory. On small plats, their nests may be traced up and treated with from 30 to 50 grammes of carbon bisulphide and the hole then covered with damp soil. Seeds grown in boxes are protected by isolating them over water, or by painting the edges of the box with creoline or some of the strong smelling derivations of wood tar.

CHAPTER TWENTY-FOUR

FARM ANIMALS

257. Care of stock. A work animal is not unlike any other machine. The better the care given, the better and greater amount of work it will perform. Most of our farm work animals are insufficiently fed to be capable of good or long sustained effort. As a rule, after a day's work they are tethered out, where they must browse on coarse weeds or innutritious grasses. As a result the next day, after a few hours of light work, they tire out, or if put to any hard strain, collapse entirely.

258. Correct feeding. The carabao is naturally a strong and most efficient beast. One of them properly fed is capable of nearly as big a pull and has twice as much endurance as two that are treated in the ordinary way. It then resolves itself into a simple sum in arithmetic for the farmer to determine whether the double work performed by one well-fed animal does or does not offset the cost of so feeding it.

All animals, of whom hard labor is expected, should be fed a daily ration of dry forage and some dry grain food. To this a small addition of green fodder may be made, although this last is not indispensable. An exclusive diet of green grass, however nutritious, has a softening effect upon the muscles of draft animals which weakens them. If worked under such conditions they get rapidly pulled down and inefficient.

A good animal condition can only be built up by degrees. Such a condition is best brought about by observance of the following rules:

1. A well selected, well proportioned grain and dry forage ration. This means one selected in reference to the size of the animal and the nature of the work required to perform, and not necessarily all the food it can eat.
2. Uniformity in the quantity and quality of the ration fed.
3. Regularity in the hours of feeding and watering.

Nothing is to be more strongly condemned than our too common practice of letting an animal shift for itself and then, on some occasion calling for heavy or unusual work, to load it up on an unaccustomed feed of grain. Not only is the extra feed quite wasted, but many times results in serious injury to the animal.

259. Various grain rations. Palay (unhulled rice) that has been roughly broken in a mill undoubtedly makes the best grain ration for animals in this climate. Corn, and the cake remaining from the crushing of oil seeds, are better adapted for feeding horned cattle than horses. These foods, however, by reason of their larger oil contents, are heating and should be fed sparingly except to animals continuously engaged at very hard work. They induce unworked animals to rapidly put on fat instead of muscle, and are therefore useful to fatten animals for slaughter.

260. Other uses of a good ration. Every provident farmer who uses work animals grows forage for their maintenance. A portion of this may be used as green fodder, but the bulk of the crop is converted into dry forage. The methods by which forage is cured and preserved has been explained elsewhere. Yard or stall feeding of cattle with a fixed, well balanced grain and dry forage ration, aside from being the way to keep work animals in the best condition, serves another and invaluable purpose. It is an assured way of obtaining a continuous supply of the cattle yard manure so indispensable in nearly all profitable farm operations. The droppings of cattle that run at large are scattered, deposited where not wanted, and generally of inferior manurial value. That of the stall fed animal is not only available, but increases in value with the quality of the ration fed. The gain is always sufficient to offset the increased cost of a good ration.

261. Need of rest. Animals that are hard worked are benefited, if, for a month or two of each year, they are given a complete rest and change of diet. In the case of shod horses, the shoes should be removed and the animals turned into a good, well watered, well shaded pasture. A few days before required for use they should be brought in and restored to their usual ration.

Another exception is made in the case of animals with young who, with more advantage, may be allowed to run in good pasture. Not only does the diet of green feed promote a flow of the mother's milk, but the foal or calf will make an earlier and stronger development upon the tender herbage than if fed dry provender.

Breeding is an exhausting process, and the pasture lands of the dams and their young animals should be of the best. If these lands are inferior the pickings of the animals should be supplemented with a mixed daily feed of green fodder and dry hay. Our general practice of breeding a broken down, half starved mare, and then turning her out to pick such stunted grass or rank weeds as she can find upon the roadside, inevitably results in the ricketty, worthless live stock with which too many of our farms are afflicted.

CORN-FED PIGS. THE WAY THEY SHOULD BE KEPT.

262. Work of breed animals. Mares in foal, or with foal running, should not be subjected to very hard work. At all other times, and contrary to the custom of the country, they should be used.

A pair of small or medium sized native mares, if well broken to harness and well fed upon a part grain ration, will draw a seven-inch plow as easily as a very large carabao. They are capable of working more hours in a day, will move nearly twice as fast, will do nearly double the farm work and should be worth nearly twice as much money to the farmer. For all garden, orchard, or other close cultivations these animals are much to be preferred than carabao, whose great bulk and spreading horns often damage the growing crops.

All our farm animals should be broken to work in teams of threes or fours; horses and mares to harness and horned cattle to yokes.

263. A home=made yoke. Yokes are easily made from any strong, hard wood (madre de cacao is excellent) and are shaped with two or more arches, instead of the single one we employ for single animals. Bows of stout bejuco, 2 to 3 cm. in diameter, are used to hold the yoke in position on the animal's neck.

NATIVE STEERS BROKEN TO WORK TO DOUBLE YOKE.

Holes are drilled through the yoke and into one an end of the bow is tightly wedged. The other end is fitted loosely, and when bent up into the yoke is held in place by a wooden pin.

264. Carabao for heavy machinery. Carabaos, notwithstanding their large horns, are so tractable and intelligent that they are easily taught to work when yoked up two or three abreast. The farmer who avails himself of this fact has at his command the means whereby he may operate the best modern farm machinery. Teams of two or three animals should, if possible, be worked abreast instead of tandem. This saves power that would be lost if the object to be moved is remote from the motive force.

265. Need for shelter. Cattle of all kinds that are restrained from running at large should be provided with sheds in which they may seek shelter from sun, rain, or wind. Exposure results in loss of condition that can only be repaired at the expense of additional food. The carabao, nearly amphibian though he be, if given the opportunity, will seek shelter from a beating rainstorm.

266. Humane treatment. The provisions of shelter, pure water, good food, and good care for animals is kindness, and kindness always pays in more ways than the material one of dollars and cents. The blow, the kick, or the cuff is almost always uncalled for. The failure of the beast to act as desired can most times be traced to its failing to understand what is wanted, and a little patience and forbearance are generally more fruitful in results than harshness. Unnecessary punishment of dumb animals is cruelty, and cruelty stuns, bewilders and makes the stupid animal still more stupid. Worse than all, it degrades and debases the one who inflicts it below the level of the poor brute victim. On the other hand, the one who is kind and considerate to his dumb animals will insensibly elevate his own nature, radiate kindness and cheer to those about, and earn the love and respect instead of the hatred or dislike of those with whom he comes in contact.

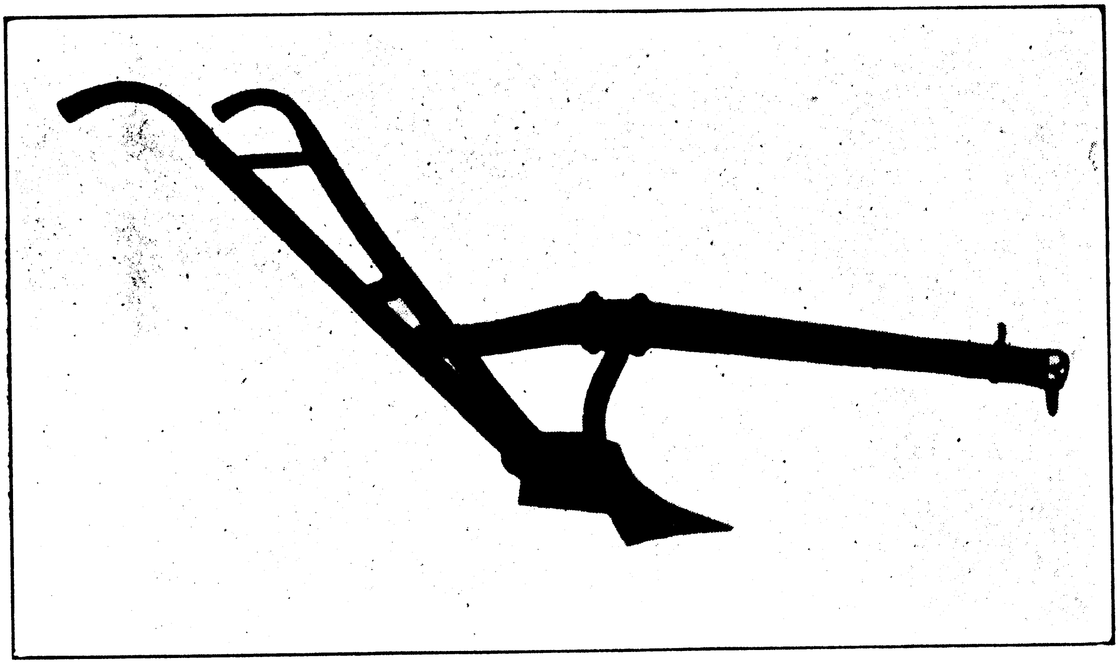
CHAPTER TWENTY-FIVE

FARM AND NEIGHBORHOOD ECONOMY

267. Attention to small things. The big operations about a farm are always looked after; the small things are apt to be neglected. The small things, in the aggregate, amount to a quantity always worthy of the farmer's close attention.

Have a place for tools, and when not in actual use see that they are kept there and not temporarily at some more convenient spot. A mislaid tool is no better than one lost if not to be found at the time most wanted.

268. Care of tools. Clean and shelter from sun and rain tools that are not in use, and when wanted they will be found in good condition for use.



A MODEL PLOW FOR WAXY CLAY SOIL. IT HAS ONLY A SLIGHT FLARE TO THE MOLD-BOARD AND WILL SCOUR READILY.

Whenever a plow, hoe, spade, shovel, or knife of any harvesting machinery has acquired a good, bright polish see that it is so kept. For tools in frequent use cleaning at night and merely wiping with an oily cloth maintains them in this condition. When they are to be laid by for a season, see that the burnished parts are perfectly dry and then rubbed over with a little tallow and black lead. When needed they are easily cleaned with a little gasoline.

In our greasy, clay soils it is difficult enough to "scour" a cast-steel plow, and far worse if it happens to be wrought steel. No workmanlike job of plowing can be done with a foul plow, and the wasted minutes of endless stoppages in the furrow to scour may be saved ten times over by taking simple precautions for having a bright plow.

269. Disposition of waste. Do away with all animals that are not kept in such condition as makes them useful for work, or cannot command a ready sale. Keep no dogs nor pigs as scavengers. While there is waste matter everywhere there should be no waste. The proper disposition of waste matter is the compost heap. There it is worth more as manure than as food to keep dogs and swine in a half-starved condition.

270. Road work. If the farm lies upon a public road or highway the farmer should contribute time or money to its upkeep. It is more his business and more to his interest than anybody else's and pays. The building of a stone ballasted road is costly, and its repair after long neglect nearly as great. Both construction and repair are beyond the reach of the ordinary individual and are functions of government. Government, like God, is most helpful to those who help themselves, and those districts that display the most zeal and activity in the care of their roads are those that receive the most public assistance in building new ones.

Road repairs, when taken in hand at the first sign of an injury, are most always within the control of one workman. At the smallest indication of a break the farmer should promptly go to its repair. He should keep his neighbors alive to the necessity of doing the same thing and stimulate them to form neighborhood improvement clubs for this purpose. If he fails to arouse interest he should not become discouraged but stick closely to the upkeep of his own frontage. In time he will win and shame the more indolent or careless into joining hands in his effort.

271. Necessity for good roads. Good roads are as vital to the farmer's success as are seeds, tools, and farm animals. Without good roads he has no possible incentive for a good crop, and bad ones limit him to producing no more than he can consume. If he produces more, he cannot haul the surplus to market except at double or more the cost of taking it over a good road. This extra cost is sometimes greater than the profits on the produce and consequently it does not pay to grow.

272. Hygiene. Observation of the simple laws of health should not be neglected. The dweller in towns as a rule can more readily command medical attention than one who lives upon an isolated farm or in a remote barrio. It is not recommended that the farmer should be his own doctor, but it is advisable that he should know a few elementary laws of health whose observance will diminish the necessity for doctors.

Strict cleanliness should be the rule about house, person, yard, pens and outbuildings. No accumulation of filth or rubbish should be tolerated except in the compost heap. If that is treated in the proper manner, it is a source of neither discomfort nor ill health. Stagnant water should be promptly drained away from about yards and dwellings. If neighbors will co-operate in like work, the plague of mosquitoes will abate or disappear, and with their disappearance some of the diseases now attributed to "night air."

273. Neighborhood clubs. Neighborhood, or cooperative clubs, are often useful agencies in securing sanitary policing, communal irrigation facilities, a pure water supply, and other useful things that the farmer, unaided, could hardly hope to secure.

Of these, pure water contributes more to the general good health of the farm than all other causes, and bad water is responsible for more death and disease than accidents, exposure, hunger, and hard work combined.

274. Pure water. Where village necessities call for the use of a stream for washing clothes or for bathing, community interests insist that its uses for these purposes should be confined to the closest possible limits. Water after flowing for a considerable distance over sand or gravel frees itself of many impurities. Hence, if liberal distances upon a water course are protected from contamination, the water can be kept fit for all domestic purposes except drinking. For this purpose it always should be boiled, and the boiling (actual ebullition, not mere heating) should continue not less than ten minutes.

275. Drying of clothes. Household linen and wearing apparel, when laundered, should be hung upon lines to dry rather than spread upon the grass. This precaution, when attended with bodily cleanliness, will prevent some of the serious skin diseases (eczemas) with which so many are afflicted.

276. Unwholesome foods. Eat of no root used in native cookery except boiled or baked until entirely tender. A number contain fibrous or woody matter that thorough cooking renders more tender and digestible. Others contain unwholesome principles that are only entirely dispelled by long cooking. Avoid sleeping in any room, particularly if occupied by others, unless with wide open windows. Foul air is chiefly responsible for serious catarrhal and pulmonary diseases, enemies more to be dreaded than the entrance of a ladron, or even a chance python. Fresh air is always tonic, and evils alleged to result from exposure to night air are not sustained by facts.

Living along the lines proposed above is conducive to good health, and nearly all the blessings and good things of life are corollaries of good health.

CHAPTER TWENTY-SIX

THE EXPERIMENT PLAT

277. Value of experiment. To the student of agriculture there is no field of observation so replete with interest as the experiment plat, and none whose facts are so loaded with useful information as those derived from this source. It is none the less valuable to the one actively and actually engaged in farming, and no farmer, be he rich or poor, though he operates one hectare or one thousand, .can really afford to be without a small trial ground or experiment plat.

The piece of land set apart for this purpose, so far as possible, should represent the general soil average of the farm, and should be large enough to form a fair basis for comparative estimates of yield. The product from a single, selected, carefully measured square meter is not a reliable factor to use in determining the yield of one hectare. A piece of one hundred meters, however, with allowances that experience will suggest, affords a suitable basis for estimating the yield of larger areas.

The foundation upon which all experiment plat tests depend is comparison. That is, comparison of the tested thing with the normal or ordinary. These comparisons are measured by what is called the check plat, a bed or piece of land subject to the same physical influences that affect the thing being tested. The check plat may be used in connection with two, three or more trials conducted at the same time.

278. The check plat. To illustrate this we will suppose that a check plat has been measured and seeded to sugar cane, on land that has been prepared and is subsequently cared for according to the custom of the country. Other plats of identical size, and as nearly as possible the same soil, are then prepared and planted. One may be given a deep subsoiling and subsequent culture similar to the check plat. Another may be given subsoiling and future frequent tillage. Still others may be irrigated in the dry season and handled differently as to deep or shallow cultivation. It will be seen that the field for investigation is practically limited only by the desire of the inquirer to learn. Written records should be kept. It does not pay to trust to the memory every item of expense or labor connected with the experiment that is not common to the check plat.

There are incidents connected with most farm operations that vary from year to year, and that must be duly considered in so far as they may separately affect check plat or experiment plat. Flood, disease, or insects may influence one and not the other, and for all these things allowance must be made. On this account, the conservative farmer extends his experimental plantings over a number of seasons before committing himself to a radical departure from old methods.

In every field of farm activity the opportunities for experimental works are as unlimited as in the example cited above, and, if carried out with intelligent care and effort, seldom, if ever, will result in unrewarded labor.

279. Range of utility. Through the experiment plat we may determine the practical value of all home compounded manures, and their relative value to the commercial fertilizers sold in the market. It is here that the productiveness, quality, or hardiness of new grains, grasses, fruits or vegetables are most surely demonstrated. It is the court of last appeal to settle the respective merits of different implements, and different methods of soil preparation and cultivation, as well as mulching, pruning, irrigation, drainage, or remedies for the abatement of plant enemies and diseases.

The experiment plat is the kindergarten wherein the rudiments of agriculture are best illustrated. It is the school wherein higher principles are more clearly demonstrated. It is the post graduate course whereby the advanced student may successfully cope with the most difficult problems, and finally become master of the most progressive and useful art known to mankind.

APPENDIX

280. Spraying mixtures. There are hundreds of preparations in use for treating plant diseases and controlling insect enemies, but it is not needed that the farmer should charge his memory with any but the very best. For this reason, only those recognized as pre-eminently the best in the class of disease for which they are recommended are given.

For the prevention and cure of fungus diseases, within the limits mentioned in the chapters on disease, the standard remedy is known as BORDEAUX MIXTURE. For this the formula is the following:

Copper sulphate	1.8 kilog.
Fresh lime	1.8 kilog.
Water	190 liters.

Two small barrels, or tubs, about 1 hectoliter each, and one of about 2 hectoliters capacity are required. The copper is to be dissolved in one of the smaller barrels in 95 liters of water. It should be suspended in a coarse cloth bag at the top of the barrel where it is completely covered by the water. If placed in the bottom it will not all dissolve.

The lime is then to be gradually slaked in the other barrel by adding water in small quantities until the lime is smooth and creamlike, and then it is diluted with the remainder of the other 95 liters of water.

The contents of the two smaller barrels are now slowly poured into the larger barrel, stirring and mixing vigorously as they are poured.

If these precautions are observed, and fresh, i. e., unslaked, lime is used there should be little or no sediment to clog the nozzle of the spray pump.

If it is impossible to procure unslaked lime, and the air soaked article is used, it is best to increase the quantity a little and to avoid getting the undissolved particles in the mixture, the lime wash should be strained through a coarse meshed piece of cloth or gunny sack.

The lime itself has neither curative nor disease preventive properties, but it serves the necessary purposes of fixing the copper so that it will not wash away after light showers, and of protecting tender foliage from being burned by the copper.

Sulphate of copper should never be dissolved in any tinned vessels, as it will quickly corrode and destroy them.

281. Insecticides. For insects that chew or bite, the standard remedy is PARIS GREEN.

When unadulterated, Paris green is nearly pure arsenic and is prepared as a spraying mixture as follows:

Paris Green	125 grams.
Water	200 liters.

Paris green *mixes* with water, but does not dissolve, or but sparingly, and while in use must be constantly stirred or agitated to prevent settling of the green to the bottom of the vessel. If it is first mixed with a little water into a thick paste it will mix more readily with the full amount of water than if turned in as a dry powder.

As a precaution against burning the foliage, a quantity of lime water can be added to the mixture in one-half the proportion recommended for Bordeaux.

Paris green is advantageously and economically used in *combination* with Bordeaux mixture. The occasion for this arises, when, as unfortunately too often is the case, plants are attacked by fungus disease and insect enemies at one and the same time.

282. Insecticides for sucking insects. No general remedy is so good as kerosene suspended in water. It is possible to churn the oil with hot soap suds until it forms a creamy emulsion, which, when properly diluted with water, may be sprayed upon the plant. The preparation of emulsions, however, is both tedious and exacting and may be dispensed with if some of the excellent devices for the mechanical mixture of the oil and water are used. The best of these sprayers are provided with separate oil and water tanks, and so constructed that at each stroke of the pump a fixed amount of oil is withdrawn, intimately mixed with water, and delivered in a mist-like spray where desired. These kerosene sprayers are provided with indicators which may be set to accurately control the proportion in which the mixture is to be used. In general a fifteen per cent mixture of oil is strong enough to destroy most sucking insects. Mixtures as concentrated as one-fifth oil and four-fifths water may be used without injury to most plants, provided the precaution is taken to spray only in bright sunny weather.

For BLACK SMUT of palay and other grains:

Sulphate of Copper	2 kilos
Water	200 liters.

The copper in this is dissolved in the manner recommended for Bordeaux mixture. The seed grain to be treated is loosely tied in bags of convenient size and soaked for a few hours in the mixture. Grain that is intended for immediate sowing should be spread for a few hours in the sun so as to be dry enough to run freely through the hand of the sower or through the seed drill. If drainage planks are arranged, upon which the bags of grain can remain for a time, the excess of liquor will drain back into the vat or tub in which it was soaked and may be used over and over again for the same purpose.

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